The
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MODERN SPRING GOVERNORS

Constant Energy Governors and Energy Increasing with the Speed Governors

BY FRANK C. PERKINS.

Among the most important of modern spring governors, employed for the regulation of speed of steam turbines, vertical and reciprocating steam engines and internal combustion engines, as well as hydraulic turbines of the leading plants abroad, should be mentioned those of constant energy of the "de Temple" design and the spring governors of Hartung design with equilibrated levers, in which the energy increases with the number of revolutions. The above well-known

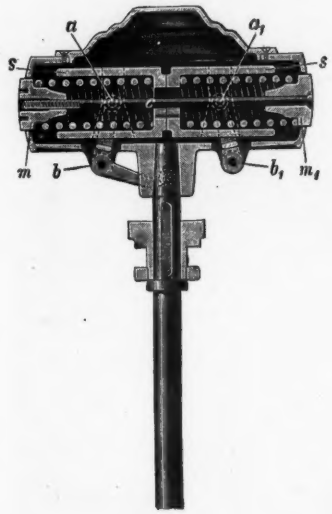


Fig. 1

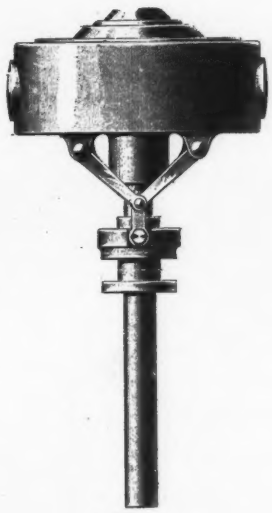


Fig. 2

governors, as well as the power governors of Prof. Stumpf and the spring governors with great variation in the number of revolutions of Temple system are being employed by the leading manufacturers abroad of pumps, compressors, blast engines, ventilators and hydraulic accumulators, as well as of ice-making machines and paper-making machines. These governors are shown in operation in the leading plants abroad, in the accompanying illustrations, with the various applications to steam engines, steam turbines and gas engines.

The general adaptation of these governors in the most important central stations, hydro-electric plants and other installations abroad, as well as by the leading manufacturers in Belgium, France and England, will insure an interest in the details of construction and method of operation of these German spring governors for various uses.

It is well known that the change in speed due to load variations does not depend entirely upon the governor, but also upon other causes; for instance, the valve gear and fly-wheel, in the case of a steam engine or gas engine. The governor's influence is due to its sensitiveness, its speed-altering power and number of revolutions, as well as its variation of speed, and the good regulation of a whole machine must not only take these quantities into consideration, but others inherent in the machine to be regulated as well.

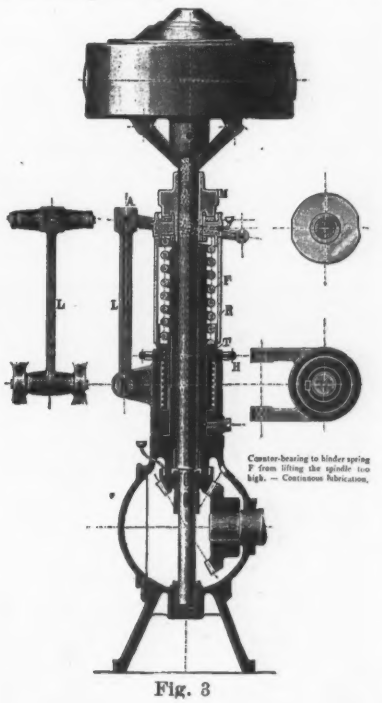


Fig. 3

In the case of an engine, to properly decide upon the right

kind of a governor and its design and construction, the dimensions of the same must be noted, the stroke, normal and maximum indicated horse power, as well as the minimum, normal and maximum revolutions per minute. The weight of the fly-wheel must be noted, as well as the radius of center

Fig. 4

of gravity of the rim of the fly-wheel, *i. e.* the distance from the axis. The percentage or variation of speed of the fly-wheel must be decided upon, and the nature or kind of machinery to be driven by the engine must be considered.

It is also important to note the type of valve gear, whether the valve gear exerts any back pressure upon the mechanism of the governor and whether any oil-brake is contemplated.

whether the change of speed is to be effected by means of an electric motor or by hand, and whether an adjustment is to be arranged for altering the number of revolutions, as well as the highest and lowest number of revolutions to be attained by this regulating device.

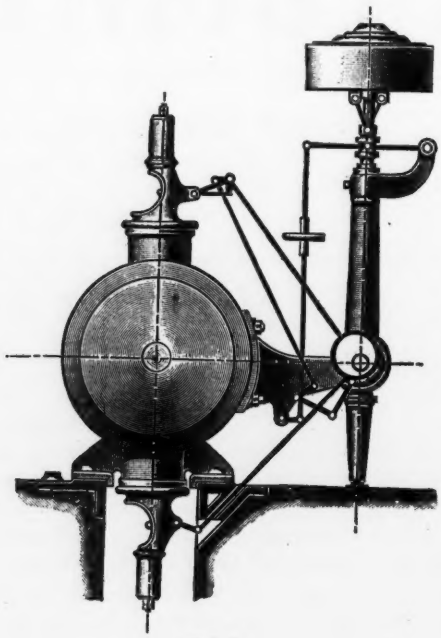
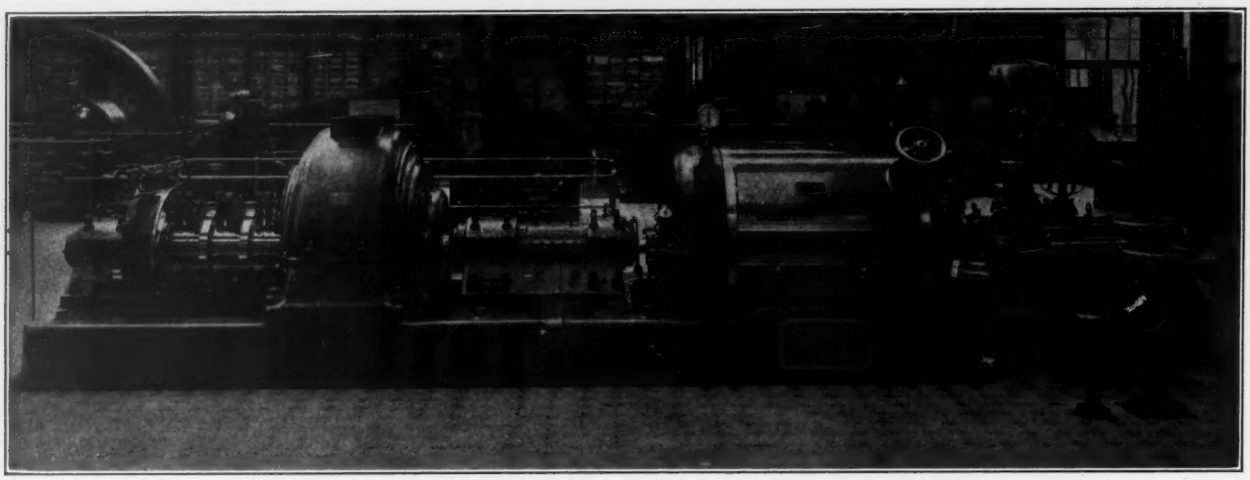


Fig. 5

On account of the extensive use of direct connected engine and generators for electric stations, there has been a great demand for accurate conditions of regulation, and in order to obtain the greatest possible capacity for regulation, the machine working with a great number of revolutions per



Horizontal Steam Turbine regulated by Spring Governor

The data as to the highest absolute pressure of live steam must be given, as well as the variation of speed allowed under normal working, also when slowly changing from maximum to minimum as well as from minimum to maximum load.

The resistance of the valve gear must be measured at the coupling box or governor sleeve, and it must be decided

minute must have a fly-wheel as heavy and as big as possible, a valve gear with the smallest possible resistance, and to be regulated by a spring governor with swinging motion perpendicular to the axis of rotation, with great energy and small travel, the friction of the latter being reduced to a minimum.

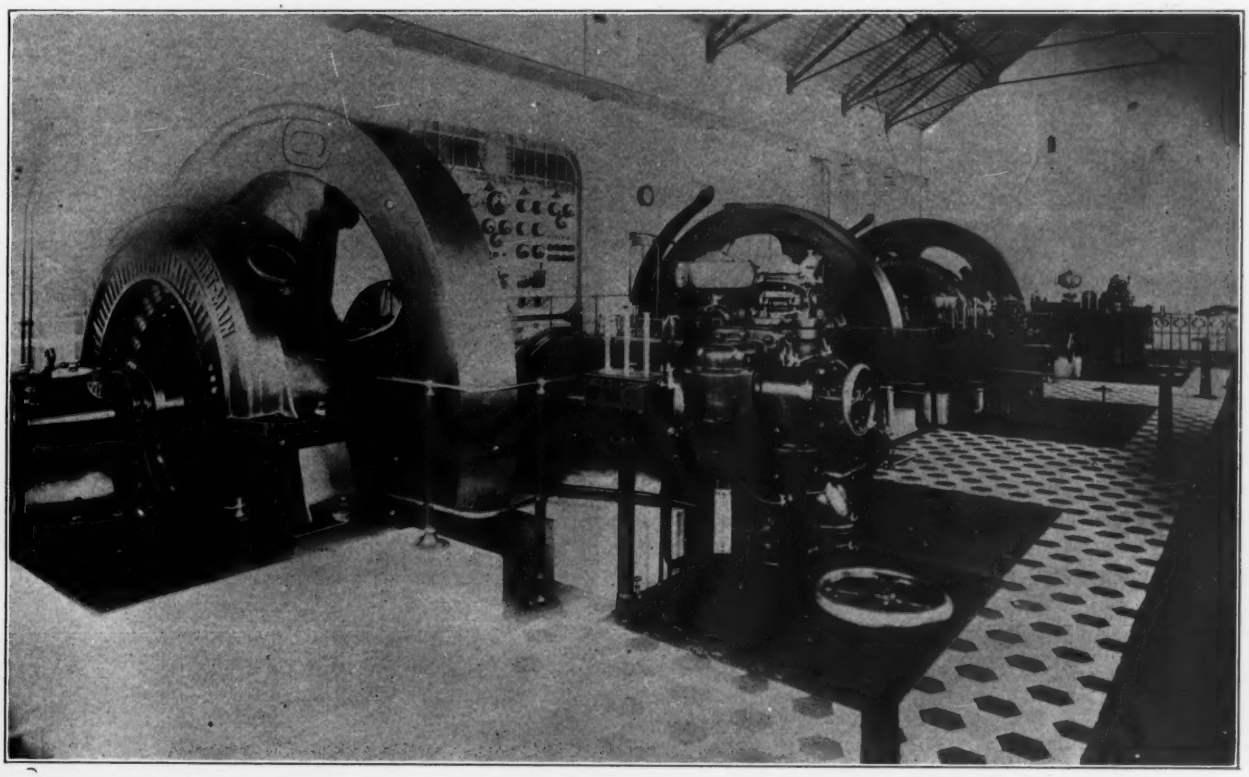
It is maintained that the efficiency of the Hartung spring

governor is high, as well as the capacity for regulation, on account of the levers being free from pressure caused by centrifugal forces. It is held that the levers and bolts are subjected only to the pressure caused by the weight of the sleeve, lever and swinging weights and the diminished speed-altering force, without the absorption of the centrifugal forces of the swinging masses.

It is stated that the degree of sensitiveness of these governors, resulting from its own friction, is only a fraction of 1%. The Hartung spring governors with equilibrated levers, shown in Fig. 1, the energy increases with the number of revolutions; the alteration of speed can only be brought about through a spring regulator. With the Temple spring governor with constant energy, shown in Fig. 2, the alteration of speed is brought about by spring regulator or change of load, while the Temple power governors for pumps, compressors and blast

larly to the axis of rotation, with two springs inside, the connection between the revolving weights and the bent levers being hinged. It will be noted in Fig. 1 that the weights are kept in their relative positions to the springs when revolving, and in this way the action of the centrifugal force and that of the spring is obtained without the use of an intermediate lever. It is stated that for this reason no pressure due to either of these forces act on the levers while the action of the governor is transmitted, nor by the cone of rotation, but directly by the hood that carries the bent levers. It is held that the energy of these governors changes and even increases with the number of revolutions.

The Temple spring regulator, for constant coefficient of speed fluctuation, is provided for the above spring governors, for the parallel working of steam dynamos, when desired, as it is often necessary to be able to change the speed of the



Three 250 H. P. Gas Engines driving Generators regulated by Spring Governors

engines with great variation in the number of revolutions, specially designed for great changes of speed, are provided with an equilibrating acting spring, as shown in Fig. 3.

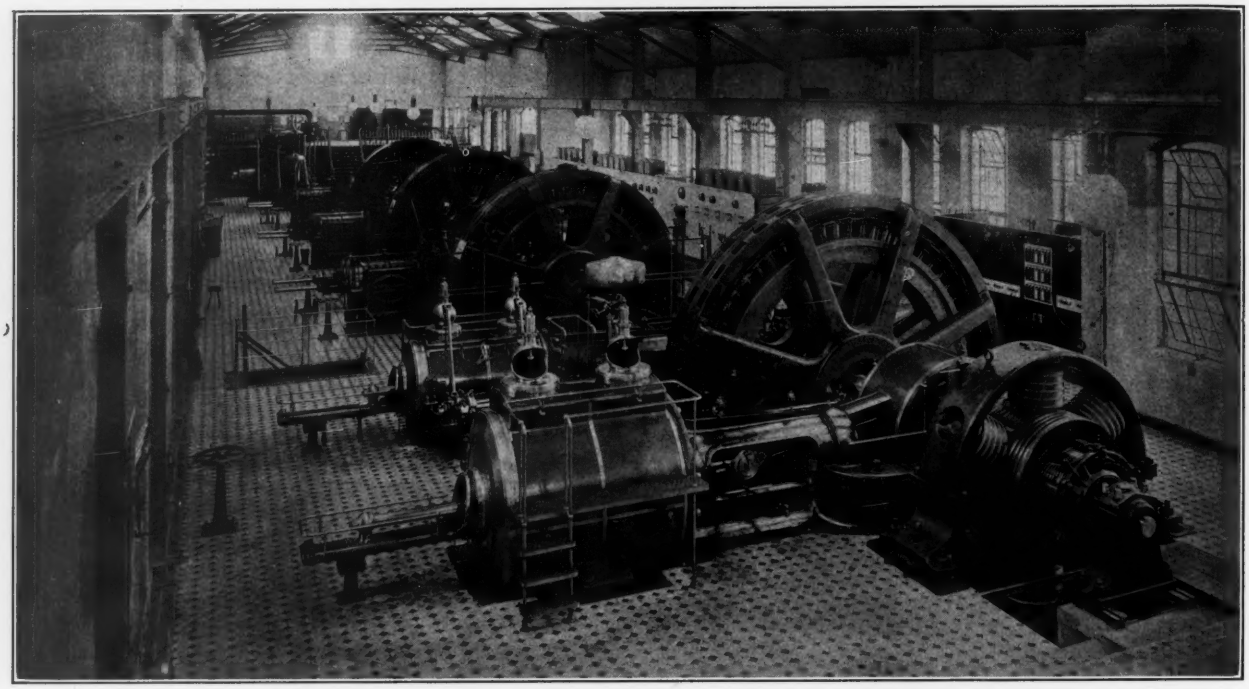
The first two types are designed for alterations of speed of 10 to 15%, and in order to reduce as much as possible the length of the spring regulator, it is necessary that it should be fixed just half way between the axis of the governor and the fulcrum of the regulating lever. The hand-wheel works in a bracket fixed to the standard of the governor.

The Hartung spring governors with equilibrated levers, the energy increasing with the number of revolutions, are designed with the levers, not between the loading spring and the centrifugal force as often used, but outside the two causes of friction and thereby equilibrated. There are in this governor two cylindrical weights bored hollow, revolving perpendicu-

governor during work without altering perceptibly the coefficient of speed fluctuation.

In proving the above mathematically, the diagram representing the additional forces which affect the energy of the governor would assume the shape of a parabola. With reference to spring-forces this parabola is represented by chords, each chord corresponding to a separate spring. By this means a spring regulator construction is obtained with several springs, in which the coefficient of speed fluctuation remains nearly constant, this spring regulator being always fixed in a position half way between the governor axis and the fulcrum of the regulating lever.

In the Temple spring governor with constant energy, the alteration of the number of revolutions is accomplished in two ways, by weighting and by means of simple spring loading.

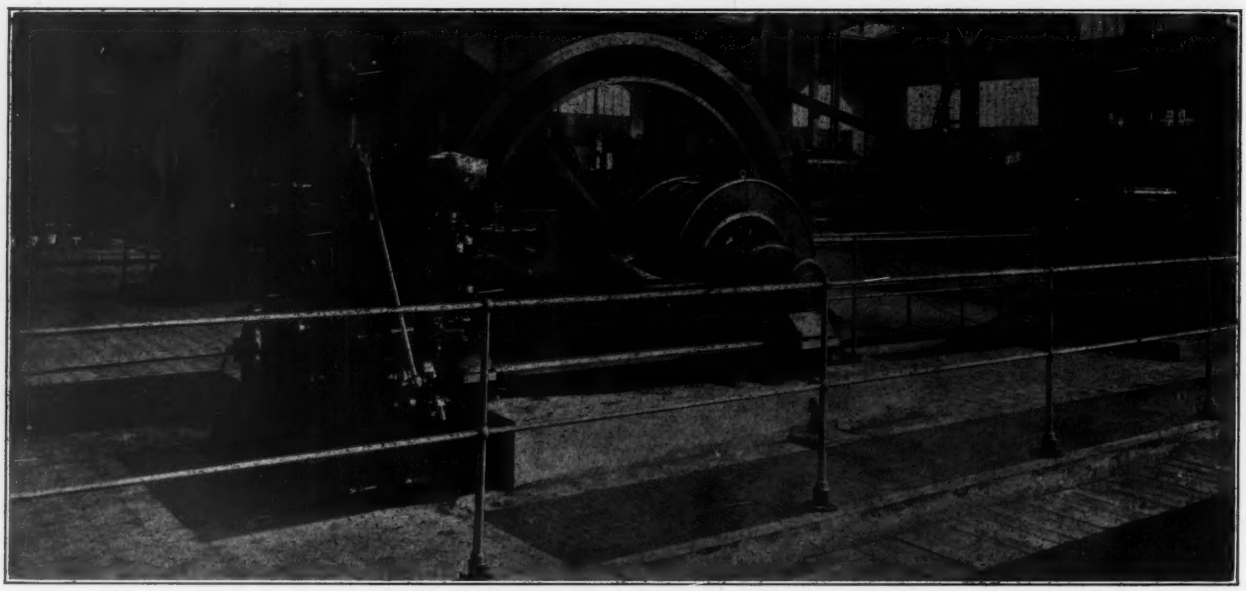


Compound Steam Engines equipped with Spring Governors and Lentz Valve Gears driving Alternators

In the first case the change in the number of revolutions is obtained by means of a sliding weight, which can both add or take off weight from the sleeve, and in consequence of the constant energy the coefficient of speed fluctuation is not altered. The change in the number of revolutions by means of simple and direct spring loading is easily determined as to speed variation in consequence of the constant energy. German engineers maintain that the advantages include the independence of the coefficient of speed fluctuation from eventual constant loading or unloading of the sleeve by means of parts not equilibrated. It is also maintained that the coefficient of speed fluctuation is not altered by the tension of the additional spring, and the coefficient of speed fluctuation can be regulated at will when fitting, by changing the tension of the main spring. In this way the smaller the tension used, the greater the variation, while the greater the tension of the spring, the smaller the variation.

The change in the number of revolutions is counterbalanced by the additional spring without alteration of the coefficient of speed fluctuation already obtained.

The Temple spring governor with great variation in the number of revolutions gives accurate regulation at all speeds



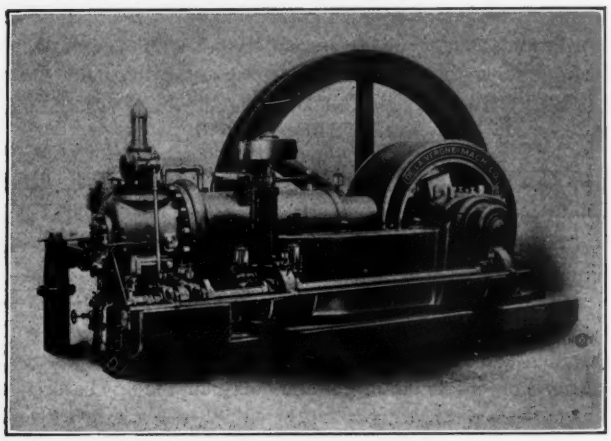
Gas Engine, regulated with Spring Governor driving Alternator and Exciter

and positions of the sleeve, both under changes of load and of steam pressure, and there is no additional throttling of the steam necessary when the revolving speed varies. It is maintained that it is impossible for the machine to run away through the breaking of pipes, as the governor at once assumes the position for running light.

On account of the governor assuming the position for full steam on coming to rest, the machine starts from all positions. The least pressure is exercised by the equilibrating spring when the number of revolutions is highest, the highest pressure with the lowest speed; so there is no side rubbing due to uneven lifting of the sliding ring.

The Temple spring governor with great speed variation effects this change by means of a change in the energy of the governor (loading or unloading of the sleeve), taking into consideration the instability of the coefficient of speed fluctuation of the machine. The change of revolving speed in this governor is effected by means of a coil-spring around the shaft of the governor, the lower end of that spring, secured by a spring-cup and a hand-wheel, being more or less tightened, as desired.

The tightening or loosening of the coil-spring takes place during the working of the machine, as the spring remains



Koerting Gas Engine equipped with Spring Governor

stationary. The gear lever is secured by means of a powerful rod, as the sliding ring can only move with the sleeve in a straight line. It will be noted by this arrangement, the higher the number of revolutions is, the lower the pressure of the spring, and the greater the pressure of the spring, the lower the number of revolutions. It is maintained that the friction and wear of the friction surfaces between the sliding ring and the sleeve, proportional to the revolving speed and the pressure of the spring, is reduced to a minimum.

It is held that heating is caused in many governors from the fact that the greatest pressure corresponds to the greatest number of revolutions, the loading of the sleeve being different in this way, resulting in wearing excessively and heating. It is also maintained that in this type of Temple governor the coefficient of speed fluctuation changes in inverse ratio with the number of revolutions.

The power governors of Professor Stumpf, Figs. 4 and 5, are employed to regulate machines in which the quantity of work to be done at each stroke remains constant, independently of the number of revolutions. The construction is based on the idea that the same adjustment of the valve gear may do for various positions of the sleeve.

Each position of the sleeve corresponds to a different speed of the governor and machine, as the governor is highly statical when the sleeve is in its lowest position. By providing an adjustable connecting-rod between the governor and valve gear, it is possible to cause any desired admission of steam pressure, obtained by the shortening or lengthening of the rod, to correspond to any position of the sleeve and to regulate in this way within limits corresponding to the travel of the sleeve the number of revolutions wanted.

It is maintained that the greater the difference in the number of revolutions between the highest and lowest position of the sleeve is, during the statical stroke, the greater the difference of speed of the machine, and as soon as the admission remains constant, the work of the machine is in direct proportion to the acquired number of revolutions.

It is held that his governor possesses great regulation capacity and available speed-changing force in comparison with the statical power-weight governors, in which the theoretical speed-changing force is, in many positions, entirely cancelled by the friction.

It is maintained that the engineer must bear in mind, in employing this form of governor, that the gearing ratio between the governor and the machine must be such that the highest number of revolutions of the machine corresponds to the highest speed of the governor during the statical stroke, and also that the gearing ratio between the stroke of the governor and that of the parts of the valve gear must be such that it may be possible for the governor during the pseudo-astatic part of the stroke to regulate the admission of steam from "full-on" down to "shut-off."

Directions for Setting Up and Operating Pumps

The suction and discharge pipes should, under no circumstances, be of smaller diameter than indicated by pump connections. When long pipes are used, it is necessary to increase the size to allow for friction.

Use as few elbows, tees and valves as possible. Lay suction line with a uniform grade from the pump to the source of supply, and be sure to avoid air pockets. The greatest care must be taken to make the suction line absolutely air tight, as a very small leak will supply the pump with enough air so that little or no water can be obtained.

A foot valve is also desirable if its location is such that the suction pipe can be drained in cold weather. The valve will insure quick starting of the pump by keeping the suction pipe filled with water.

Hot water cannot well be lifted by suction, as its vapors tend to destroy the necessary vacuum. Therefore, hot water should be arranged to flow to the pump, and this applies also to thick liquids. Keep the stuffing boxes evenly packed, but do not screw them down too tight, and give the pump reasonable attention.

In steam turbine operation, the economy gained by superheating is about one per cent. for each 10 degrees of superheat up to 100 degrees superheat and about one per cent. for each 5 degrees above that. Practice has shown, however, that it does not pay to superheat over 150 degrees.

A TALK WITH A CHIEF ENGINEER

Practical Pointers About Operating Storage Batteries

By William Kavanagh.

Talk No. 6.

For our next talk on storage batteries, the chief arranged to have Kingsley and I meet him at his engine room at 2.30 P. M., because the Chief wanted to have plenty of time to explain when the cells were charged and discharged, as these things are very important to know when operating storage batteries. On arriving at the Chief's engine room I was informed that the Chief was at the main office and would return in a few minutes. The Chief came in shortly accompanied by Kingsley and said that he had been having a talk with the president and manager of the works in reference to the calorific value of the the coal with which the boiler room was being supplied. "The manager requires a sample from each cargo," said the Chief, "so that the calorific value may be determined in the laboratory. Lately, the coal arriving at the boiler-room has been of poor quality and in order to show my disapproval of the coal, I sent a sample, which was mixed with slate, to the laboratory. The manager found fault with the sample, as he requires that the sample should contain no slate. I strongly objected to this because I claim that the calorific value of the cargo cannot be determined by sending only pure coal, and as the cargo contained a considerable amount of slate, the sample should contain some. The manager opposed this idea but the president backed me up and said that an allowance must be made for the slate, which will hereafter prevent any department from being charged with the consumption of a good grade of fuel when I am receiving just the opposite kind."

The Chief then began his talk on storage batteries by saying, "I believe, Kingsley, we are to discuss the charging and discharging of your storage batteries, and if you are ready I will proceed to give you some necessary information on these two points." Kingsley replied that he was ready to receive any information that the Chief might give. "Well, Kingsley," the Chief said, "you know in my last talk with you, I gave you a sketch of the battery panel board and I also explained to you the use of the various instruments the panel board contained, so that I will assume that you are familiar with the instruments and their use. When your batteries are erected," continued the Chief, "one of the cells will be selected as a pilot cell which acts as a guide for all the other cells. In this pilot cell will be placed an instrument, called a compensating hydrometer, and this hydrometer will, when properly handled and understood, be a guide to inform you when your battery is in need of charging or when it is discharged. Now suppose the battery is discharged and the hydrometer registers 1180° and when it is fully charged it will register 1200°, in which case the hydrometer will rise or fall 20° between charge and discharge. Now suppose the battery was giving out current for lighting and power purposes for a period of ten hours and by inspecting the hydrometer we found that the gravity of the electrolyte fell from 1200° to 1180°. We may then begin to charge and continue charging until the hydrometer registers 1200°. When this gravity has been reached the charging should cease. If at any time the load carried by the generator is too great for the battery to handle, the generator must continue to run until the load has fallen sufficiently for the battery to take care of it.

"The capacity of a cell," said the Chief, "depends upon its ampere-hour output. If a battery is capable of developing 100 amperes for a period of 10 hours, it will maintain a current of 200 amperes for 5 hours or it will give out 50 amperes for 20 hours. Of course, in charging a battery, it is always best to do so when the load on the generator is small because when the load on the dynamo increases, the battery can be cut out and allowed to remain idle while the dynamo is carrying the heaviest load. If, however, the load on the dynamo should happen to rise too high, all you have to do is to throw in the discharge switch of the battery and in this way the battery can be made to carry a portion of the load and assist the dynamo over the highest peak of the load.

"Whenever it becomes necessary to use the batteries to assist the dynamo, the battery may be made to take a greater or lesser portion of the load by raising the voltage on the battery. Accordingly as the end-cells are cut in on the line, it elevates the voltage for a given time, depending upon the demand of current

BATTERY CHART

WEEK OF ..... 1907 ..... ENGINEER

	HOURS A.M. 1	2	3	4	5	6	7	8	9	10	11	12	HOURS P.M. 1	2	3	4	5	6	7	8	9	10	11	12
SUN.															1180	1188	1186	1190	1194	1198	1200			
MON.													1180	1183	1186	1190	1192	1196	1198	1200				
TUE.													1180	1182	1184	1190	1192	1194	1198	1200				
WED.													1180	1182	1184	1188	1192	1194	1196	1198	1200			
THU.													1180	1182	1184	1186	1188	1192	1194	1196	1198	1200		
FRI.															1180	1184	1188	1192	1196	1153	1200			
SAT.															1180	1186	1188	1192	1196	1200				

and as we continue connecting end-cells to line, we will be rapidly approaching the time when we must either charge the battery or cut it out of circuit. It can readily be seen that when the last cell is cut in on the circuit, the voltage of the battery cannot be raised, hence the voltage will fall and the battery would be receiving current instead of assisting the dynamo. After the last cell is cut in, the hydrometer will begin to drop rapidly showing that the gravity of the electrolyte has decreased. Never allow the gravity of the electrolyte to fall below 1180°, if possible. It is poor policy to allow the battery to stand without being charged and it is also poor policy to regularly overcharge the battery because of the rapid wasting away of the plates. It is, however, good practice to overcharge the battery once in every ten days, but overcharging should not be attempted until the cells are filled and the gravity of the electrolyte in each cell made equal or as near to it as it is practical to do so.

"When the cells are charged," explained the Chief, "the gassing lowers the electrolyte and exposes a considerable amount of surface of the plates and for this reason the amount of electrolyte lost by the formation of gas must be replaced. A hose connection should be arranged in the battery room so that water may be had to replenish the cells. The cells showing the lowest gravity should be strengthened by adding undiluted sulphuric acid and the cells showing the highest gravity are filled with water or diluted acid, the object being to so equalize the

strength of the electrolyte that each cell will do the same amount of the work. In filling the cells use rubber gloves so as to escape any shocks due to the current following the water back through the hose. When the cells are properly filled, a considerable amount of plate surface will be covered with the electrolyte thus increasing the efficiency of the battery. The more surface of the plates that is exposed, the less will be the amount of current that can be obtained from the battery. Hence, every eight or ten days, the cells should be inspected for gravity and filled as I have explained. When this is done you can overcharge; otherwise, it will be a waste of energy to overcharge the cells.

"Another important point about the care of battery cells is cleanliness. You see Kingsley," said the Chief, "that the constant charging and discharging of the cells wastes away the plates and this waste is deposited on the bottom of the cells. If allowed to accumulate, it will in time rise high enough to short-circuit the plates, thus destroying the use of the cell or cells in which the short-circuit was allowed to form. In order to determine the height of the sediment in each cell, you can take an inspection lamp and by viewing the height or depth of the sediment in each cell, you can tell when the proper time to clean the cells arrives, and in this way the short-circuiting of the cells may be prevented. You can make a wooden scoop for this purpose and by passing it down between the side of the cell and the nearest plate, you can scoop out all or nearly all of the sediment. In all probability, the erectors of your storage battery will supply you with a right and left-hand scoop and also an inspection lamp.

"The inspection lamp is a small, flat incandescent bulb, the voltage of which is usually 4 volts, the current for lighting the lamp being supplied by two cells of the battery. The bulb of this inspection lamp is attached to a vulcanized rubber tube in which the leads for the lamp is carried and therefore protected from the acid; hence, by carrying the lamp from cell to cell and connecting the leads across two cells, light can be obtained in every cell. The lamp and tube are made flat so as to permit of its insertion between the plates and in this way it can be seen whether the plates are washed or wasted.

"The hydrometer is kept in the pilot cell and hourly readings should be taken from the hydrometer during charging. The readings are written down on a chart and reference to this chart will show the rate at which the battery was charged for any particular day and the length of time required to charge or elevate the gravity of the pilot cell. Let me make you a sketch of one of these charts because it will be necessary to understand this." The Chief then drew a sketch similar to the one shown here which gives the readings for the different days of the week and the different hours of each day. In explaining the chart, the Chief said:

"Charging began at 3 P. M. on Sunday and continued up to 9 P. M., showing six hours as the time required to charge, the hourly rate of rise in the gravity being written opposite each hour. It will be noticed that it became necessary to begin charging earlier each day as the week advanced, showing an increased demand for current and also a weakening of the electrolyte. On Friday and Saturday, the demand for current decreased and the batteries were charged later in the day. A new chart is begun each Sunday and by properly dating and filing them away, they will show how the battery was handled on any particluar day.

"Before closing this subject," continued the Chief, "I want you to remember the following points: *First,* the battery should be charged when the load is light on the dynamo. The battery will then be able to assist you when the load is heavy. *Second,* charge at the regular rate and always charge up to the required gravity point. *Third,* overcharge regularly every ten days and when the overcharge is complete no further rise in gravity will be registered by the hydrometer, the rise, in gravity at overcharge being usually from 8 to 10 degrees above the regular point. You can tell when the battery is overcharged by charging for one hour extra and if no rise in gravity is apparent, the battery is overcharged. Thus at regular charge, the hydrometer records 1200° and at overcharge 1208°, at which point the battery is cut out. *Fourth,* keep the cells well filled and the gravity of the electrolyte up to the standard. *Fifth,* keep the cells clean and free from grounds and if you have been attentive during my talk, you will not find any difficulty in operating this source of electricity which is bound, sooner or later, to become an auxiliary to every isolated plant of any respectable size throughout the country."

Production and Value of Natural Gas

One of the most valuable fuels found in this country is natral gas and for the first time the U. S. Geological Survey have been able to give the quantity of gas which is produced in the different States. According to the figures just published, the total amount of natural gas produced in 1906 was 388,842,562,000 cubic feet measured at atmospheric pressure. The value of this gas product is $46,873,932, which was produced in the different States as follows:

GAS PRODUCED IN THE UNITED STATES, 1906.

State.	Quantity, M cubic ft.	Cts. per M cubic ft.	Value.
Pennsylvania	138,161,385	13.4	$18,558,245
Ohio	45,436,020	15.7	7,145,809
West Virginia	119,400,392	11.5	13,735,343
Kansas	69,322,633	5.8	4,010,986
Missouri	33,500	21.5	7,210
New York	2,547,769	26.4	672,795
Indiana	7,861,140	22.2	1,750,715
Kentucky	789,154	36.4	287,501
Oklahoma	3,520,396	7.3	259,862
California	153,021	87.9	134,560
Alabama, Louisiana, Texas	1,038,569	14.5	150,695
Illinois	409,556	21.3	87,211
Colorado	23,567	96.7	22,800
Arkansas, Wyoming	120,500	28.6	34,500
South Dakota	22,900	67.2	15,400
Tennessee	2,000	15.0	300
Total	388,842,562	12.1	$46,873,932

As shown by the table, Pennsylvania ranks first in the amount of production followed by West Virginia, Kansas, Ohio and Indiana in the order named. The average price of the gas was 12.1 cents per 1000 cubic ft., or $5 per short ton. This price is interesting considering that the corresponding price of bituminous coal in 1906 was only $1.11. The difference is made up by the fuel efficiency of natural gas, weight for weight, and by the great economy of labor in its use and cost of removing ashes. Pumping of natural gas has tended greatly to the steadying of the industry and to the development of enterprises dependent on it. The transportation of the gas is so much cheaper than that of coal that the gas competes with coal at comparatively greater distances.

THE VALUE AND EFFICIENCY OF STEAM SEPARATORS

By J. O. Frazier.

Referring to the question of F. L. P. in your November issue, regarding the efficiency or real value of a steam separator on his engine, I would like to say that I have many times been in his same quandary when asking for a separator for my own engine room, and also when selling to others, where I could see at a glance that a steam separator would be a mutually profitable installation, but have never been able, in dollars and cents, nor in percentage of improved efficiency on the engine, to tell just *how* profitable. The particular reasons I would give for this lack of knowledge in the art of determining values would be that each individual case has its own value, depending on the circumstances of the case; and even this value is variable, from time to time, depending on the amount of entrainment and condensation to be taken care of, on the character of the water of entrainment, on its content of grit, which will promote wear and friction, and also on the kind of separator used.

It is not likely that any engineer, particularly those who have used a particular engine before and after the installation of a separator, will dispute the statement that there is no situation (except, perhaps, with superheated steam), where a separator will fail to be a profitable investment, even in cases where steam is on the average of the driest and best quality. We have no positive assurance against high water in the boiler, bad water, a drop in the steam pressure causing a flush, or spell of priming. In anything like bad cases the value of the separator would, of course, be enhanced, while, in many cases, it is almost an example of criminal carelessness to operate an engine without one.

L. F. P. will have to impress upon his employer the fact that he is, at best, dealing with some unknown quantities. First, the amount of water to be dealt with, which consists of both entrainment and condensation, and which, while capable of very close determination at a given time, is so variable, ordinarily, that it would be difficult to determine the average. Again, we must find the maximum and consider this the average, and provide for taking care of that amount, and last but not least, the proportion of the total water removed and the value of this removal must be determined; all of which will probably explain why books and people exploiting separators have so little *exact* information to impart on the subject.

The most serious aspect of operating without a separator is the liability of the engine becoming wrecked from an overdose of water which will more than fill the clearance space of an engine, and if some of the connecting parts are not immediately broken, fractures may result, which will at some later date give out (if not discovered before final give-way), and perhaps with the engine running with easy load, everybody will wonder why it gave way and the engine running so nicely. I have in my own experience come across fractures in piston, piston rod, cross-head, connecting rod or crank pin, which, considering all the circumstances known about the engine, seemed more plausibly to have occurred in this than in any other manner.

Perhaps the greatest total loss by the failure to use separators occurs in just such cases as F. L. P. mentions where the situation is such as does not appear to call loudly for the use of a separator, but where, day after day and year after year, the difference between a cylinder full of wet steam and a cylinder full of dry steam is nibbling off the profits in so small a stream as to escape the notice of those who do not give consideration to these matters. Many such plants have cost more in wear, extra lubrication and diminished efficiency than others, where the situation was so bad that the need of a separator was apparent and one was installed.

In all the most advanced commercial plants of the country where special attention is given to every detail looking toward safety and high efficiency, they begin at the boilers, endeavor to have ample boiler capacity, which means a steady steam pressure and less liability to flooding their engines; they get the best boiler feed water obtainable, which promotes steadiness of water level, and then go to their engines and take a last shot at conquering the priming difficulty by hunting up and installing what they believe to be the best separator they can find. Further than this, unless a separator is to be drained back to the boiler, a reliable steam trap should be used, as a separator, unless draining back to the boiler, is not a complete machine without a trap. It will arrest, but will not dispose of the water.

As an instance of illustrating the difference between a cylinder full of dry, and one of wet steam, which is sufficiently accurate for demonstration to a layman, I would suggest that F. L. P. (if he uses a direct-acting steam pump for a boiler feed) show his employer the speed of such pumps when running a long time with cylinder cocks tightly closed, especially if in a cold place, then open them and note the increase of speed, which in the case of the engine would not necessarily mean increased speed, being presumably controlled by a governor, but would indicate a correspondingly diminished consumption of steam, which should have some value as an argument for the separator. There are often small matters of this kind which will convey an argument to a non-professional person with greater chance for conviction than an ordinary argument which, even if properly made, is too obscure for the man from the office.

Now, as regards the value of a separator in an aggravated case, a number of years ago in a sugar house of which I had charge, we had put in new boilers, and changed the feed water from bad to worse. We found that one of our main engines, a 24-in. x 48-in. plain slide-valve engine, which was run at about fifty revolutions per minute, could not be safely entrusted to run without close attention, as we had to slow it down when it got a dose of water, which was very frequent. We had an 8-in. separator in our exhaust system, which could be dispensed with, so we moved it to the steam line of this engine, and, in increased output of the mill, due to being able to maintain normal speed, this separator almost paid for itself each day during the season. It is probable it would also pay for itself in a year, in the difference in cylinder oil and perhaps again in wear, which it would save, to say nothing of the value of greater safety to property and perhaps life.

I think F. L. P. has a mild case if a separator would not pay for itself in fuel economy alone in a year, in lubrication in perhaps a somewhat longer time, and as a safeguard against a possible breakdown from a flood of water, its value would be hard to fix.

It may not be amiss to suggest that in any case where the general conditions are not bad, one should be proportionately more careful in the selection of a separator, because, while the poorest separator ever made will comparatively cure the worst cases, it is the last few per cent. of water in the steam which is hard to separate, and takes the most efficient separator you can find to do it. My argument may not have directly answered F. L. P.'s question, but it illustrates the difficulty of finding other than general arguments, which I have no doubt he has used as effectively as they could be. It is to be hoped, however, that the above may suggest some elaboration of his argument, or will help him to search for some convincing illustration which may lend strength to his cause and land a separator for him.

Methods of Constructing Concrete Foundations

Concrete makes an ideal foundation material, says a writer in *Machinery*, since, when it is set, it becomes practically one solid piece. The method of construction is much different from putting up a masonry foundation, and much less expensive. The bed is prepared and the templet is carefully set to

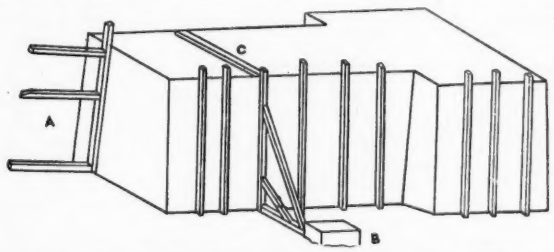


Fig. 1. Foundation Form Set up and Braced for Filling

center line as described before. All concrete work is molded in forms. The timber for these forms should be about 1 inch thick, dressed on one side for the purpose of getting a smooth surface on the work, and braced about every 2½ feet. Fig. 1 shows a foundation form set up and braced for filling. Two methods of external bracing are shown. At *A* the braces are carried horizontally to the side of the excavation; at *B* a piece

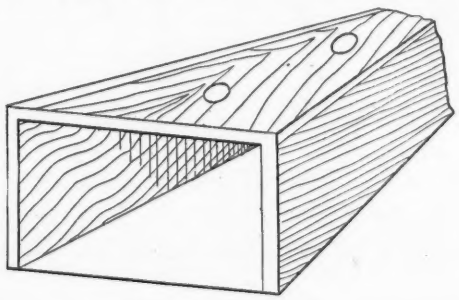


Fig. 2 Pocket Mould

of timber is firmly set in the ground, outside the base, and all bracing brought to it. The inside of the form should be braced about every foot in height; the upper brace of one of these sections is shown at *C*. Such braces are placed inside for the entire height of the foundation, spaced as just mentioned. As the concrete is put in place the braces are removed.

The form should be carefully placed to the layout of the foundation, and pocket molds set. Fig. 2 shows a pocket mold, and Fig. 3 a top view of the form set ready for filling. The pocket molds are simply wooden boxes of the same outside dimensions as the pocket is required inside, and finished smooth.

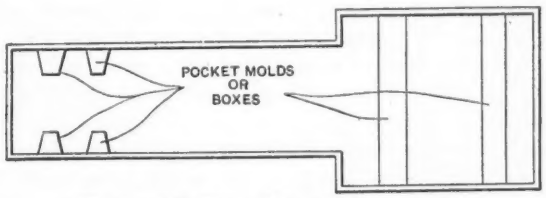


Fig. 3. Top View of Form Ready for Filling

These molds should be soaked in water 2 or 3 hours before using to prevent their swelling and sticking in the concrete. They may be nailed to the main mold, or wires may be fixed to them, which pass through the main mold, and tightened by means of wedges in a manner similar to that used by a molder in holding suspended cores. These pockets must be firmly fixed in place.

The next step is filling the form. Do not use concrete that has stood mixed much over 20 minutes. Ram with rammers weighing about 1 pound per square inch of face area, and ram until water just shows at the surface. Put down in layers about 6 inches thick, and work down next to forms with a shovel to get a smooth surface. The foundation may be filled with good sized stones, about the size of a man's head, about 1 foot apart and at no place less than 1 foot from foundation surfaces. Wet these stones before laying. If the work is stopped at night, make grooves in the surface, and when starting next morning sprinkle and dust over with dry cement.

As soon as the cement has set, strip off the forms, as it is much easier to patch when cement is somewhat green.

Foundation work is sometimes "slushed" instead of being rammed. In this case, the concrete is mixed just wet enough so it cannot be piled up. The concrete is then dumped into molds, and worked in them to prevent air bubbles. The first method gives a more homogeneous structure, as there is no chance for the broken stone to settle. Turn the pipes occasionally as the foundation goes up, to prevent their becoming set, if they are to be removed. Sometimes they are left in the foundation as a sort of lining to the foundation bolt holes.. When the machine is set approximately true, the space around the foundation bolts may be filled with liquid cement, lead, or melted sulphur.

Refrigation Used in Smelting Iron

The use of low temperatures has become an important factor in the smelting of iron. Large refrigerating plants are already in existence and more are being erected for the purpose of dehydrating the air supplied to blast furnaces for the reduction of iron ores. By the use of refrigeration, the smelter is made independent of atmospheric conditions, and the air-blast is sent to the furnace at a constant and low rate of humidity, increasing its output from 20 to 25 per cent. and decreasing the cost of production of the metal about 20 per cent.

A 6-in. x 8-in. VERTICAL GAS ENGINE

Specially Designed for the Practical Engineer

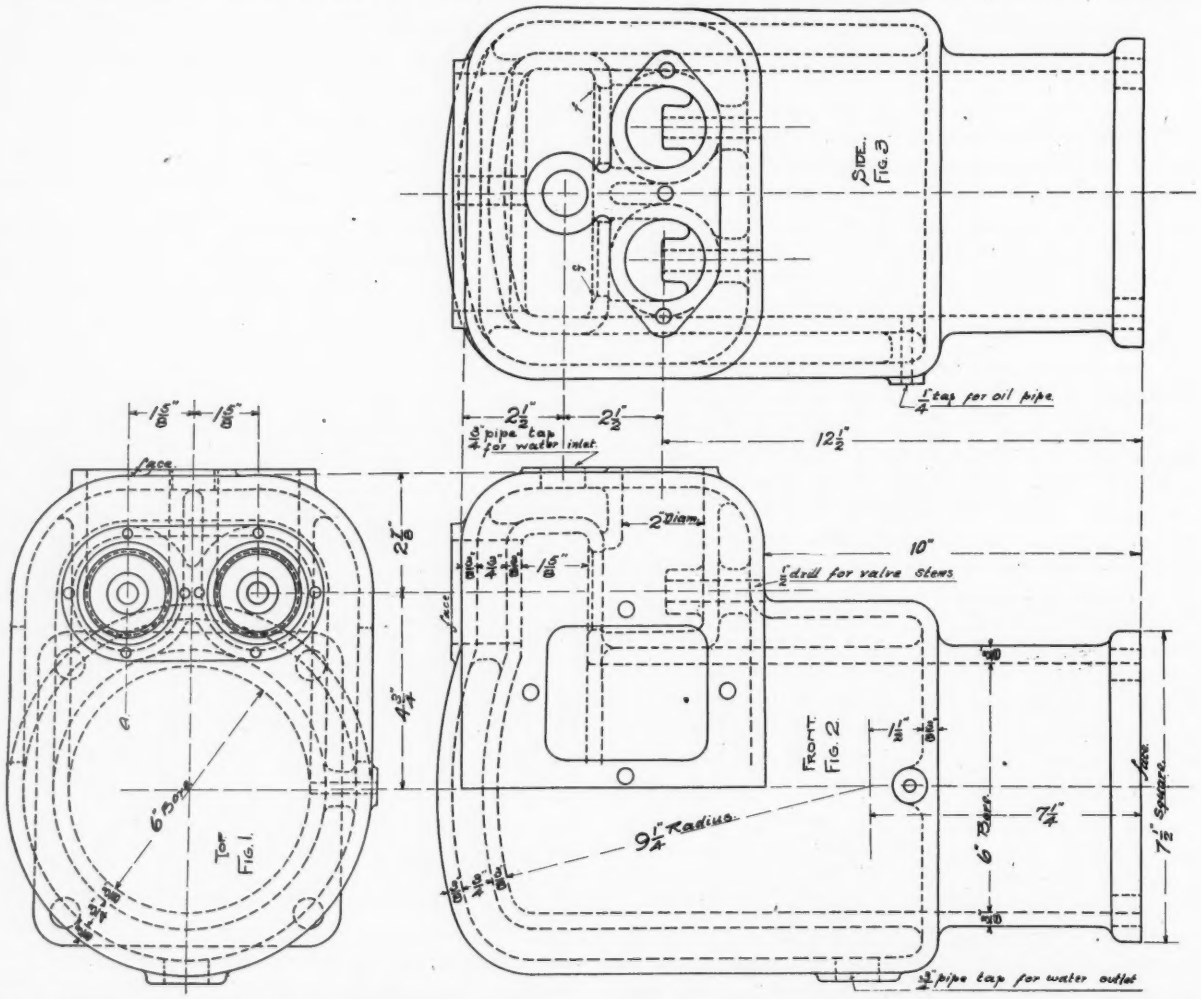
By A. Edward Rhodes.

When designing an engine of any kind, whether it be for steam or gas, the horse-power that it is to develop must necessarily be taken as a starting point. Having decided upon the horse-power, the bore of the cylinder, the stroke, the compression, the clearance of the piston and the other details of the engine may be determined.

In designing this engine, I decided that it should develop 5 horse-power at the brake; that is, the actual horse-power that the engine will transmit. It must develop this power under the following assumed conditions: mean effective pressure, 60 pounds; compression, 60 pounds, and speed, 300 revolutions per minute. If a very good quality of illuminating gas is used and a slightly increased number of revolutions, the engine should develop eight horse-power. Any explosive gas may be used and if a special carburetor be used for starting and running the engine until the cylinder is sufficiently hot, kerosene may be used with fairly satisfactory results.

This engine is of the four-cycle principle with mechanically operated valves because this type of construction scavenges the cylinder better than any other type, and because it is more economical in the use of fuel, for the reason that it admits a full charge of fuel at the proper time regardless of other conditions.

The engine is designed to be water-jacketed, although it will be a simple matter to substitute air-cooling flanges for the water-jacket. If made of the air-cooled type, the pattern and casting will be easier to make, but the efficiency of the engine will be lowered and a forced draft must be provided. The cylinder pattern will be the most difficult of all the patterns to make.



The best metal and most perfect surfaces should be around the valve-seats and at the compression end of the cylinder; therefore, the cylinder should be cast upside down, that is, with the part of the cylinder that is bolted to the crank case at the top of the mould.

It will be noticed that no counter-bore is allowed for at

the combustion end of the cylinder, the idea being that it is easier in this case to bore the cylinder as far as possible into the combustion chamber end, in which case the piston will have a smooth bore for its full stroke, and since the cylinder is upright there will be no appreciable wear on the cylinder, which will affect the operation of the engine. Finished pieces have not been provided at certain places, where it is usual to see them for the same reason that no counterbore was provided for; namely, that it simplifies the pattern-making and foundry work.

Referring to the drawings, Fig. 1 is a top view, Fig. 2 a top view and Fig. 3 a side view of the engine cylinder. Fig. 4 represents a horizontal section at the combustion chamber, showing the top of inlet and exhaust valve seats, water inlet and shape of water-jacket around the combustion chamber. Fig. 5 is a section taken through the inlet and exhaust con-

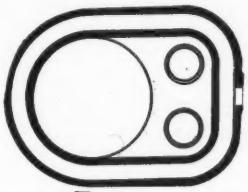


Fig. 4.

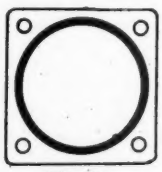


Fig. 7.

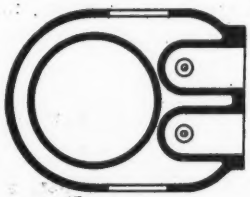


Fig. 5.

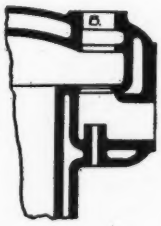


Fig. 8.

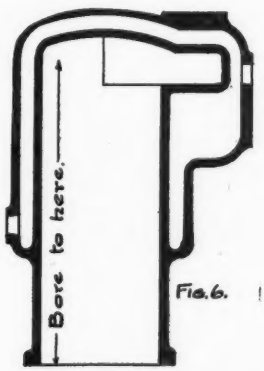


Fig. 6.

nections and shows the holes left for supporting the core used in casting the water-jacket. These holes will be closed with cast iron plates ¼" thick, each fastened by four ⅜" tap bolts. As there is no finish provided around these openings, it will be necessary to use a thick rubber packing to make a water-tight joint.

The water-jacket is tapped for a ¾" pipe both at the water inlet and water outlet. The openings at the top of the cylinder shown in Figs. 1, 2, 3 and 4, which gives access to the valves are covered by caps or bonnets fastened by 3-16" screws. The bonnet covering the inlet valve is fitted to receive the spark plug. These bonnets should be turned on a lathe and the top of the cylinder finished to receive them.

The face of the inlet and exhaust openings should be finished smooth and tapped with a ⅜" tap to receive the combination inlet and exhaust gland. A vertical section taken on the center line of engine showing the cylinder, combustion chamber and water jacket is shown in Fig. 6. Fig. 7 is a horizontal section showing lower end of cylinder, with its flange and bolt holes

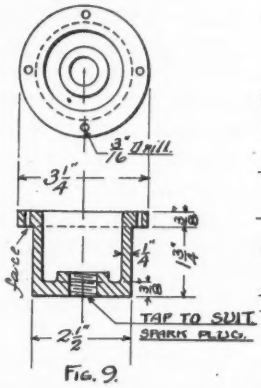


Fig. 9.

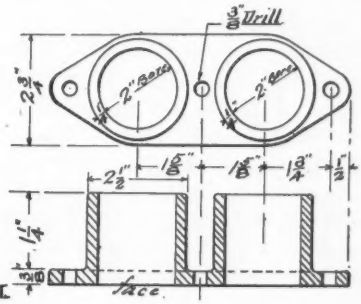


Fig. 10.

for securing it to its base. These bolt holes are for ¾" tap bolts or studs as preferred. Fig. 8 is a vertical section on line A A, Fig. 1, and shows the valve seat, opening to valve seat from top of cylinder, hub for valve stem, and shape of water jacket around inlet and exhaust passage ways. The opening marked B, Fig. 8, is 2½" diameter. The valve seat is bored 2", chamfered 45 degrees and ground to fit the valve.

The valve caps or bonnets, shown in Fig. 9 are made of cast iron, the one for the inlet valve being tapped to receive the spark plug; the other one is not tapped. The gland or connection for inlet and exhaust openings is shown in Fig. 10 and may be made of cast iron or brass. The face on the cylinder should be made to correspond to the gland dimensions.

(To be continued.)

Waste of Artesian Waters.

According to the United States Geological Survey, millions of gallons of artesian waters are going to waste in Indiana. Over a million gallons a day are being wasted in a single county. In only a few places is this water put to use, as it is not realized that a hydraulic ram or windmill placed on a flowing well will raise a large portion of the water for available use. Owing to this waste, many wells which once yielded copious and strong flows have ceased to flow entirely, and the ground water level has been lowered ten feet. By simply capping unused wells, or by providing them with some means of stopping and controlling their flow, as is now applied to municipal supplies, the head of the wells can be preserved and the height of ground water maintained near its original level.

The Great Western Power Company, of California, will use the largest transformers that have ever been built. The total weight of each transformer is 128,000 pounds, of which 40,000 pounds is due to the 5,000 gallons of oil used in each transformer for cooling and insulating purposes. Each transformer stands 20 feet above the floor and measures 9 by 18 feet. They will be used to transmit 40,000 horse power at 100,000 volts 165 miles along the Pacific Coast, from the Feather River development.

THE USE OF LOW-GRADE FUELS

The Scarcity of High-Grade Fuels Has Made Briquetting of Low-Grade Fuels a Necessity

By Geo. E. Walsh.

For upward of fifty years now a thriving industry has been carried on in Europe in compressing fuel in the form of briquettes for commercial and industrial uses, and the machinery developed for handling soft coals, coal dust, peat and similar fuel products is of a highly refined and practical nature. Peat briquettes are quite extensively used in Germany and England, and in France, Belgium, England and other European countries coal briquettes are burnt on the railways and in private factories. A number of the ocean liners also depend upon coal briquettes chiefly for their fuel, and altogether the output of coal briquettes in Europe has averaged more than twenty million tons annually for the past seven or eight years.

The briquetting of peat has never attained the same degree of efficiency in Europe as that of soft coal, but pressed peat has been on sale for many years as a fuel. In Germany improvements in briquetting machinery has had much to do with developing this industry, and brown coals, peat and the dust and waste of coal mines generally are being converted into a fuel of compact, commercial size suitable for railway, factory and steamship use. One syndicate of manufacturers in that country sells upward of one and two million tons of briquettes a year, about one-quarter of which is taken by the German railways and 10 per cent. by the German merchant steamers. The coal briquettes used in Germany are nearly smokeless, cheap, clean and compact in form, so that where space for storage of fuel is an important factor, they prove more economical than ordinary anthracite coal.

In the past two years a number of important developments have been made abroad in the manufacture of fuel briquettes. One of these is the invention of electrical machinery for compressing peat into briquettes, and the other is the reduction of the peat to the form of a charcoal and then compressing them. The relatively low efficiency of peat makes it somewhat difficult to handle economically. Crude peat contains only from 30 to 50 per cent. of carbonaceous matter, and nearly twice as much must be used to produce a briquette of equal heating value as coal. But by transforming the raw material into peat-charcoal first, and then compressing it into brick forms, the difficulties are obviated.

In this country briquetting of coals and peat fuels has had a rather checkered career. Recognizing the immense value of this form of saving waste, engineers and inventors have steadily tried to develop the industry. The first briquetting plant in Europe was established at Berard, France, in 1842, and the first in this country at Port Richmond, Philadelphia, in 1870. Both of these early plants were abandoned owing to the imperfection of the compressing machinery. American inventive genius has been active since then in devising new methods of briquetting fuel, and upward of 100 patents have been taken out in twenty years in the United States for improving briquetting machinery. A considerable number of briquetting plants have been established near the coal mines and the peat districts of the East and West, but for all their experimental work the industry has never assumed the importance attained in Europe.

But there has developed in this country a new application of briquetting machinery which more than compensates for lack of achievement in handling coal and peat. The compression of mineral fuels has been going on in Europe for half a century, but in America we find this feature of the industry in its highest development. The reclamation of precious mineral ore dusts for smelting purposes by compressing them into briquettes has been widely successful here, and American ore briquetting machinery has been shipped in considerable quantity to South Africa, Australia and Europe.

Some ten years ago a smelting company made some rather exhaustive experiments with new machinery for briquetting fine ores, and as a result of this work a combined mixing and briquetting machine was invented. This machine has made remarkable achievements in the briquetting of gold, silver and copper ores throughout the West in the past six or seven years, and most of the big smelting companies now resort to this process of recovering their waste. It is practically a new industry that is being vigorously exploited. Big profits are being reaped by the smelting companies now resort to this process of recovering their waste. formerly went to waste. The ore and flue dust briquetting machines have been improved so that the largest have a capacity of 100 tons every ten hours. Fine mineral ores, concentrates, flue dust, and all granulated mineral fines which do not admit of ready smelting are treated and compressed into brick form so that practically all waste is recovered. Formerly this waste of a big smelter amounted to from 10 to 20 per cent.

More recently this process of recovery has been extended to include the slimes from the concentrators. These slimes could not be smelted, and they flowed down the tailings and represented in some cases great waste. Not only are the slimes now dried and briquetted, but several plants have been established for working over the tailings of smelting camps. These tailings are of enormous proportions in some regions, representing the accumulations of years of work. Thousands of dollars are being recovered from the waste heaps by the new briquetting process. Many of the old dumps are found to contain from three to five per cent. of fine ores, flue dusts and similar material, all of which are recovered in the briquette form. The blast furnace of a smelter has sufficient force to blow out a large quantity of fine ore dust. The collection of this dust in the form of briquette fuels enables the smelter to run at much greater economy than by the old process. The flue dust is caught at the top of the smelter in a funnel and carried by the gases

and fumes through a tunnel to be deposited upon special plates prepared for it. It is then scraped away and carted automatically to the briquetting machinery. It is mixed with a certain percentage of pitch or binder to make it retain its brick shape.

In the iron and steel works of the country the recovery of flue dusts is even more important than in the smelting field. The force of the blast furnace in an iron and steel-making plant is much greater than in smelters, and as a result greater quantities of ore dust are forced out. The losses are all the way from 10 to 16 per cent. in this field. The ore contained in this flue dust is rich and valuable, and its recovery and conversion into briquettes costs less than $1 per ton. It takes the place of ore worth three or four dollars per ton. Some furnaces operated with these briquettes of flue dust obtain results equal to that with high grade ore. The recovery of the dust in iron and steel blast furnaces is automatic, and does not interfere with the rest of the operation. The dust is caught and delivered by a series of dust buggies operated on an endless chain, and is then carried to large hoppers below. From here the dust is carried away in cars, to be treated with a binding agent of lime, soda ash and salt. The whole is mixed, and then compressed in the form of briquettes. These briquettes save in the iron and steel industry several million dollars annually, and further improvements in their manufacture are likely to add to this economy.

In the adaptation of the briquetting machines to the recovery of flue dusts and fine ores in the smelting business, achievements have been made which will make the briquetting of peat, coal and waste a thriving industry of the near future. The briquetting of garbage and refuse of our cities is one of the most promising and fascinating subjects for engineers. In California waste has thus converted into commercial briquettes by mixing the refuse with the hardened oil which collects in great quantities around the oil wells. This oil refuse is used as the binder, and the garbage compressed with it has great heating value. In the manufacture of briquettes from garbage and refuse tar, naphthaline or the accumulated waste from oil wells are employed as the binder. Garbage briquettes have been made which equal fine coal in heating value, and they possess the additional value of being smokeless and leaving very little ash. The development of garbage briquetting has reached a higher stage in England than in this country, but there is a fertile field for improving methods here. The garbage problems of cities are becoming increasingly more difficult of handling, and their ultimate solution by converting the refuse into commercial briquettes seems feasible. Crematories for burning garbage mixed with coal have been established in a number of cities, but very few have yet tried the briquettes made by modern machinery.

The briquetting of peat has not reached the same commercial development in this country as in Europe and particularly in Germany. In the latter country, the home of the briquetting industry, the coking process of peat for the purpose of compression in the form of bricks has proved one of the most economical factors in the utilization of this common fuel. As ordinary peat contains from 90 to 95 per cent. of moisture, it is necessary first to extract more than two-thirds of its original saturation before coking. Then by means of air-tight, vertical furnaces, the dried peat is converted into a coke of great commercial value. In the process of coking the by-products of distillation have proved almost as valuable as the peat as a fuel. The gas generated by the coking is drawn off and used to drive gas engines, and the tar, tar water and other products are utilized for various purposes. By this German process one ton of peat, with 90 to 95 per cent. of moisture included, produces 700 pounds of coke, 800 pounds of tar water, 80 pounds of tar and 420 pounds of gas, equivalent to 6,650 cubic feet. The tar water is further distilled, and from it comes 8 pounds of ammonium sulphate, 12 pounds of acetic acid and 12 pounds of wood alcohol. In Germany the tar obtained from the peat is utilized for wood preservation, and the coke, after compression into the forms of briquettes, is used as a fuel in the large iron and steel plants. Even the dust from the coke is recovered and manufactured into smokeless fuel briquettes, that are successfully used on warships. In a single plant in Germany about 11,668 pounds of coke are manufactured in twenty-four hours from each furnace, 13,333 pounds of tar water, 1,333 pounds of tar, and 6,999 pounds of gas, or 110,833 cubic feet.

What has proved so successful in Germany has been partly duplicated in Russia, and companies have been formed to handle commercially the vast peat bogs of Ireland. In that country with a total area of 32,393 square miles there are 2,830,000 acres of good peat bog extending down to various depths. The value of this peat may yet make Ireland a relatively important fuel country, and the time may soon arrive when England will get much of its fuel from its despised island dependency.

There is no question about the extent of peat bogs in this country, and their ultimate value as a great fuel source. There are practically millions of acres of good peat in the East and West which are to-day furnishing no returns to the country's wealth. In experiments made with the peat found in New England the calorific power when dried in the air has been found to be from 9,600 to 14,000 British thermal units per pound, which is about 65 per cent. of our best coal. The peat, when wet, weighs from 100 to 125 pounds per cubic feet, but after being dried the weight is reduced to 55 pounds. Much of the peat extends down 20 feet, and as there are 43,560 feet to the acre, this would make 860,000 cubic feet of peat mud to each acre of bog. If dried there would be a yield of 20,000 tons of peat, which, according to the technical estimates, would equal in heating power 12,000 tons of good coal. By the coking process this amount might be reduced to 10,000 tons of good coke.

At present the whole question in this country appears to be involved in the cost of excavating and drying, and not in that of either coking or compression. New machinery has been invented for cutting out the peat and for drying it so that the cost of handling has been reduced nearly 20 per cent. in the past few years. The peat is cut by machinery and carried automatically on belts or conveyors from the bog to the drying plant. In the newest types of peat machines, the excavated material is packed into rotary iron cylinders which revolve at a high speed. The centrifugal

pressure, aided by an interior heating device, expels all but a small remnant of the water contained in the original material. The great difficulty in drying peat by air on a large scale is that the work could not be carried on continuously unless the weather should prove very dry and clear. In the winter season the work of mining it would practically have to cease. The successful development of our peat bogs must, therefore, depend upon plants which dry the mud artificially at all seasons of the year. Drying machines have been operated in conjunction with peat excavating machinery by utilizing the gas from the coking as a fuel. The exhaust gases from the engines have been employed for heating the drying apparatus, and the gas engines drive the excavating machinery. By some such double purpose as this peat mining may become an important industry in many parts of this country where coal is an expensive fuel.

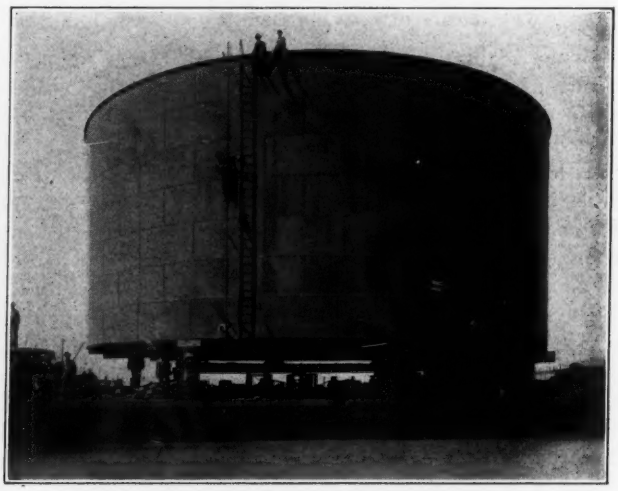
The recovery of the coal dust which accumulates in such heaps at the mouth of pits and around large storage pockets of the railroads and manufacturing plants is another fertile field which appeals to manufacturers of briquettes. This coal dust when used with a proper binder becomes rich fuel briquettes suitable for almost any kind of steaming purposes. The cost of the binder and the labor of manufacture, including the investment in the machinery, amounts to less than $1 per ton. In Germany a binder of tar and pitch that costs ten to twelve dollars per ton has been used profitably, for not more than 5 to 10 per cent. of the briquettes are composed of the bonding material. In this country equally good binding material can be had for much less than this price. The whole field of briquetting coal dust, peat, flue dust and ores is one that holds great promise for the future in this country where the price of fuel is steadily advancing. Besides the great deposits of peat, and accumulations of waste suitable for briquetting, there are enormous deposits of cheap brown or lignite coals in the Northwest and South which are to-day used very little. When converted into briquettes they make a smokeless fuel only slightly less desirable than the best anthracite. Their utilization in this form or for producer gas plants must soon make them important factors in the industrial development of new sections of the country. At present they are looked upon as potential possibilities of the future rather than as actual resources for the day, and their final exploitation must result in enriching many of the pioneers who take up the work of converting them into commercial products.

In Canada peat is used quite extensively as a fuel, and sells at $2 to $3 per ton. It burns in a furnace slowly and without smoke, and as a producer of gas it is almost equal to coal. Certain grades of peat will even yield better returns as a gas producer than coal, and at the St. Louis exhibition when tests were made with different fuels the fact was developed that with a high grade peat 2.4 pounds produced as much producer-gas power as 5.8 pounds of coal when used under a steam boiler. This fact shows one important line of future development. The producer gas plant is considered by many as the coming form of power generation, and if our peat can be utilized in the producer cheaper than coal under the steam boiler, a great cheapening of cost of manufacturing work will be accomplished. In Maine, where coal is expensive, peat has been mined to a considerable extent, and a great number of producer gas plants have been established to use this fuel. The extensive peat bogs of Florida, Michigan, Wisconsin and Minnesota have also been utilized the last few years for this same purpose, and there is a close competition between the producer plant and the briquetting plant for utilizing this universal fuel. There are three kinds of peat bogs generally recognized, but so far the difference between them from a heating point of view is very slight. They are graded as grass, moss and salt-water bogs, and when the peat is taken from either one it is little more than a thick muck.

Moving a 30,000-Barrel Oil Tank

The accompanying illustration shows a large oil tank which was recently moved from the old gas plant of the San Francisco Gas & Electric Company at North Beach to the plant of the Oakland Gas, Light & Heat Co., on the Oakland Estuary. This 30,000-barrel oil tank is over 80 feet in diameter and 33 feet high and holds more than one and one-quarter million gallons with a total weight of 172,000 pounds.

To move the tank, holes were first dug in the masonry foundations about 20 paces around the tank in order to receive the jacks. The tank was carefully raised, timbers placed under the bottom, and cribbing set in position, after which the tank was handled in the same manner as a house while on land, passing



30,000-Barrel Oil Tank in Transit

through the streets for a distance of about a mile and around a corner to the water's edge.

The tank was then run aboard two barges about 100 feet long, at high tide, in a little over an hour. The tank was towed across the bay by a steam tug for a distance of about 10 miles.

The tank was unloaded without difficulty and set in place on its new foundations without accident of any kind, and when tested it was found to be perfectly tight.

With polyphase or monocyclic machines, the synchronizing of one side of the circuit does not prove that the other phases are ready for parallel connection, unless all the connections correspond in both machines. When machines are first thrown into parallel, their synchronism can be readily found by using two sets of phase lamps which will give simultaneous indication that both phases are in step.

METHODS OF LUBRICATION

Oil Cups, Grease Cups, Sight Feed and Force Feed Lubricators and Oiling Systems

The object of lubrication is the reduction of friction between two surfaces which slide together. A perfectly smooth surface exists only in theory. With the most modern appliances it is possible to produce at the best only a comparatively smooth

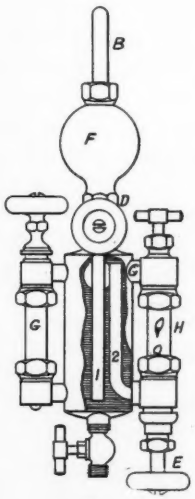


Fig. 1

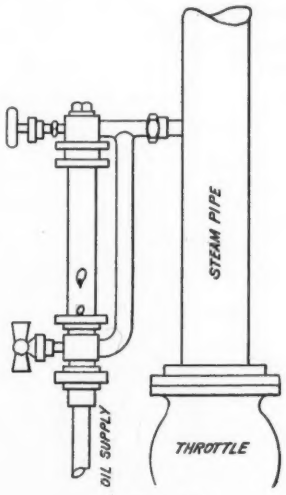


Fig. 2

surface, so that when two surfaces are placed together in sliding contact, there will always be some resistance to motion and consequent wear on the surfaces. Oil, grease or graphite is therefore used to diminish this friction by filling up the irregularities in the bearing and interposing a thin film between the sliding or revolving surfaces. To insure perfect lubrication, the surfaces must be coated with lubricant at all times and under all pressures and velocities.

The temperature and velocity at which an oil or grease is to be used, exerts a great influence over the kind that is to be selected. With an ordinary bearing, a thin oil or grease has a tendency to run off too fast, while a thick one may not flow properly. The requirements of a good lubricant for any specific purpose are therefore as follows: It should have body enough to keep the rubbing surfaces apart and at the same time be as fluid as possible; it should be of such a quality as to give the smallest possible friction; it should not "gum" or corrode the metal; it should have a high flashing point and should remain fluid at the coldest temperature to which it may be subjected.

The lubrication of cylinders is a much more difficult subject, as it depends upon what purpose and for what kind of engine it is to be used. There are four different classes of cylinders met with in engineering practice which are as follows: First, the cylinders of steam engines; second, the cylinders of gas and gasoline engines; third, the cylinders of gas compressors; fourth, the cylinders of pumps or of hydraulic elevators.

The various condition which may be met with in the above service are: First, high temperature, due either to the heat of the steam, the heat caused by compression in the compressor or the heat generated by the combustion of the charge in a gas or gasoline engine; second, water due to condensation of steam, due to the cooling effects of the cylinder walls or entrained by the entering steam; third, excessive friction due to the weight of the piston, especially in the case of horizontal engines; fourth, alkalis, such as the ammonia gas in ammonia compressors; fifth, various degrees of cold as in certain refrigerating systems in which cold gas is employed.

It is obvious from the above conditions that no single lubricant will answer all these purposes. The selection of a cylinder oil necessitates a study of the conditions of temperature, speed, pressure and moisture. It is not an easy matter to determine what oil is the best adapted for the different kinds of duty it must perform, but if, after experiment, it has been found that a certain oil gives satisfaction, then the same grade should be used continually, so long as it gives satisfaction. Much of the trouble due to the cutting of valve seats and cylinders is due to the use of lubricants which are not suited to the work.

It has been found, however, by long experience, that the best lubricant for cylinders is a mineral oil of good body with a high flashing point, because a mineral oil possesses a greater number of qualities which go to make up a valuable cylinder lubricant than any other oil. Vegetable and animal oils are not suitable in a cylinder, as they decompose easily, especially

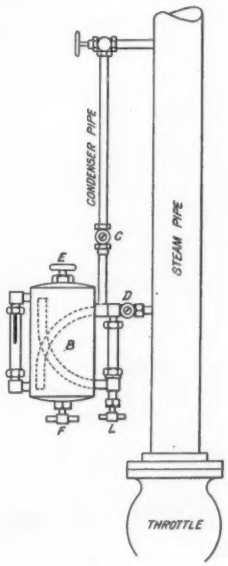


Fig. 3

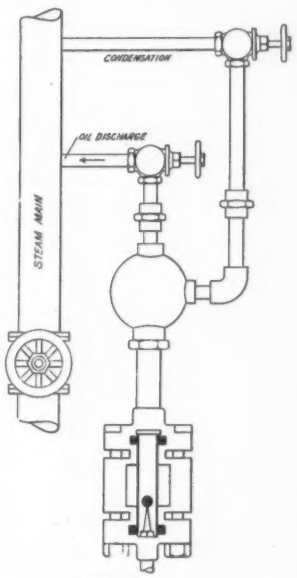


Fig. 4

at high temperatures, and tallow leaves a decompose to a certain extent, forming stearic acid which attacks and eats the surfaces of the piston and cylinder.

In selecting an oil for the cylinder of a steam engine, the viscosity of the oil is an important factor. If the engine belong to the slow speed type, an oil with high viscosity is necessary, but with high speed engines, the viscosity need not be

so high. In either case, however, the viscosity should not be any higher than necessary, since excessive viscosity tends to increase friction between the molecules in the oil itself. The flashing point is another important consideration. If the steam pressure is high, the oil should have a correspondingly high fire-test. The flashing point should not fall below 400 degrees Fahrenheit in any case, while a range of between 500

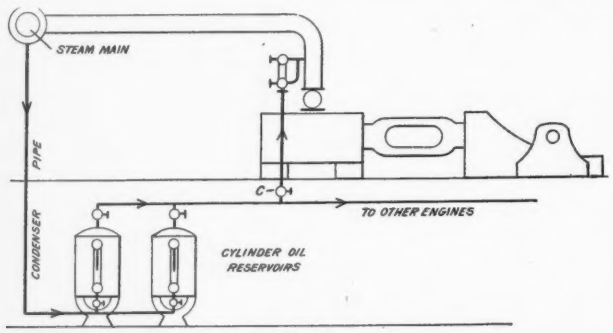


Fig. 5.

and 600 degrees is often demanded by careful purchasers. It is very difficult to get an oil that will stand a higher temperature than 600 degrees without flashing. The requirements of a steam cylinder are duplicated in a gas and gasoline engine. For compressor work, if the compressor is used for ammonia, the oil must not only stand a high fire test, but also a low cold test and be composed of purely mineral oil. In case of water cylinders, mineral oils mixed with animal oil is common, while grease is most usual for elevator plungers.

A good cylinder lubricant, which is coming into general use, is graphite. It is a mineral substance and gives an exceedingly smooth surface to the interior of the cylinder. Its principal objection has been the difficulty of feeding it into

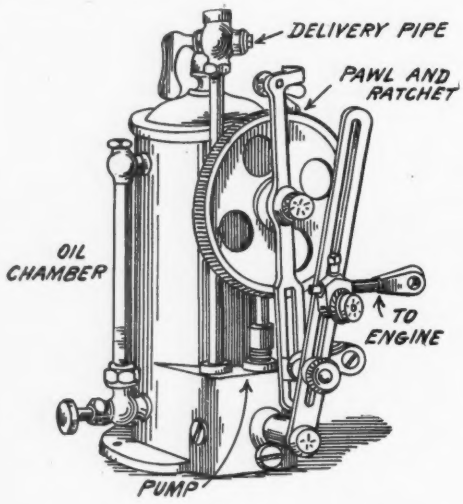


Fig. 6

the cylinder. This difficulty has now been overcome by mixing the graphite with oils. Two oils are used of about the same specific gravity, but of such a nature that they will not mix together. The graphite is then mixed with one of the oils very thoroughly, after which the mixture is added to the other oil and the distribution of the graphite is complete throughout the mixture. It has been found that this compound feeds well without clogging the lubricant, while the graphite will not settle and is always held in suspension. It has been this discovery that has caused graphite to be extensively used as a cylinder lubricant.

There are two kinds of cylinder lubricators in general use, known as the sight-feed and force-feed lubricators. The sight-feed lubricators all work on the hydrostatic principle and depend on replacing the oil in the lubricant by the condensation of steam. By referring to Fig. 1, the construction and operation of the single-feed variety can be seen. Steam comes through the pipe B, which should be connected to the main steam pipe about 12 inches or more above the lubricator, into the reservoir F, where the steam is condensed. When the valve D is opened, the water of condensation runs into the oil containing chamber through pipe marked 1. Steam also enters pipe C and the water of condensation fills the sight-feed glass H. Water in the glass H can rise no higher than the pipe C, for this pipe is in connection and level with the delivery pipe leading to the steam cylinder; consequently any more water would simply run over in the steam pipe leading

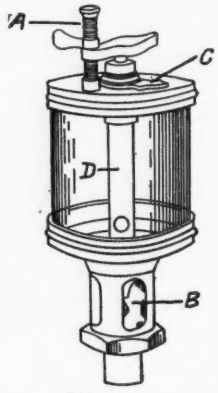


Fig. 7

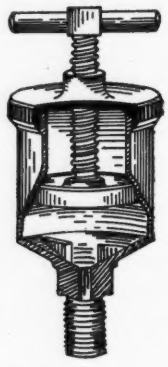


Fig. 8

to the cylinder. Water, however, can back up in the pipe B, consequently, if the valve E be opened, oil will be forced down pipe 2 by the hydrostatic pressure of the water in pipe B and the oil will rise out of the nozzle at the bottom of glass H, pass up through the water in the glass and finds its way through the pipe C into the steam pipe leading to the engine cylinder. By adjusting the valve E, any desired number of drops of oil per minute may be delivered within the capacity of the lubricator. The glass G is used for the purpose of determining the height of oil in the lubricator. This lubricator is known as the "single connection" type to distinguish it from the type having two pipes connecting it with engine pipe. The double connection lubricator connected to a steam pipe is shown in Fig. 3. Oil is placed in the reservoir B and the oil is forced into the steam pipe by the hydrostatic pressure in the condenser pipe.

Owing to the small capacity of the lubricator, it is necessary to frequently refill the reservoir B. To do this, valves C and D must be closed, valve F must be opened to drain off the water and plug E removed and the reservoir filled by hand from a can. This method of filling is most always used, when there are only several engines to be looked after, but in large engine rooms, where the quantity of oil used per day is large other methods are resorted to.

One of these methods is shown in Fig. 5. When this method

is used, independent sight feeds, such as are shown in Figs. 2 and 4, are used on the engine. They have no attached reservoir, but are connected to the steam pipe at a convenient point near the throttle and are supplied with oil from a central reservoir, as shown in Fig. 5. This reservoir is conveniently made of one or two barrels' capacity and is conveniently

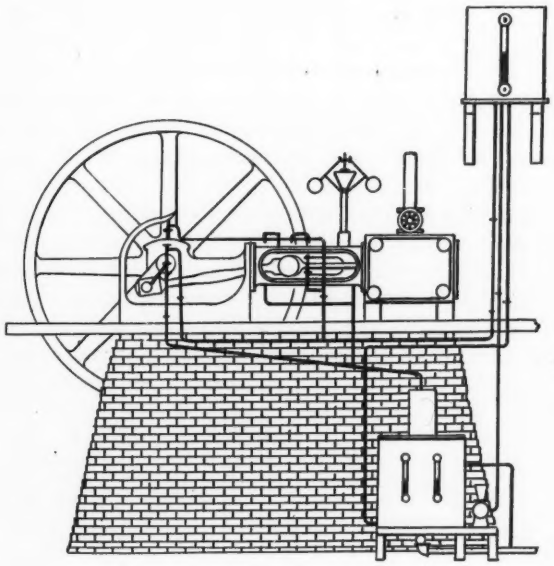


Fig. 9

located near the engine level. A condenser pipe leads from the steam main to the bottom of the reservoir and the condensed steam fills up the reservoir as fast as the oil is fed out. It is then in exactly the same condition as the reservoir B in Fig. 3, and the oil is under a pressure equal to that of the steam plus that due to the head of water in the condenser pipe. A distributing main takes the oil from the top of the reservoir and leads past several engines, from which main a small pipe leads up to each lubricator as shown. The reservoirs are shown in duplicate, so that one may be filled while the other is in operation. There are no returns to be taken care of and the whole system is absolutely automatic in its action.

As an improvement on the hydrostatic feed systems, "pressure" systems are used. They feed the oil through independent sight-feed lubricators, such as shown in Figs. 3 and 4 under a steady pressure, generated and governed independently of the steam pressure. Two kinds of pressure are in common use: direct mechanical pump pressure and compressed air pressure. When mechanical pressure is used, the oil is forced through a distributing pipe under a pressure of about 25 pounds in excess of the steam pressure. When air pressure is used, the air pressure is generated by a small direct-acting air pump and the air pressure, being applied to the surface of the oil in the reservoir, forces the oil throughout the system.

The advantages of a positive feed has led to the development of the force-feed lubricator positively driven by some part of the engine gear. They are all small mechanical oil pumps and the amount of feed can be easily regulated. They are made with single or multiple feed, depending upon the service to which they are to be put. They consist of a closed oil chamber to which are attached one or more pumps, and as they can feed oil of any viscosity, they are not subjected to any of the difficulties of the hydrostatic sight-feed lubricators.

One of the best known makes is that shown in Fig. 6. There is a compound-lever motion combined with a ratchet movement which permits a very fine adjustment of the feed to be made. These lubricators are designed to feed oil against any pressure up to 1,000 pounds per square inch, the valves, both for inlet and discharge being double in order to insure tightness. The glass shows the amount of oil in the lubricator reservoir. The pump is of the plunger pattern and is driven from the engine by a cam. At each revolution of the cam, a quantity of oil is discharged into the cylinder.

A somewhat different construction of lubricator employs a screw rotating in a nut which drives the pump plunger in and out of the pump chamber. The throw of the pump plunger is governed by the throw of a slotted arm, which is governed by the throw of the adjustable crank pin. This pin may be fixed at eight points, which gives eight feeds from maximum to minimum.

The most common method of lubricating bearings is by placing the oil or grease cup directly above the journal to be lubricated and then depend upon gravity or springs to force the oil between the shaft and its bearing. A form of oil cup most generally used is shown in Fig. 7. It consists of a glass shell which shows the level of the oil in the reservoir. The feed is adjusted by turning screw A and the number of drops being fed per minute can be seen at B. The oil reservoir is filled at C. The interior of the spindle D, contains a spring which keeps the feed valve on its seat when screw A is lifted off its top.

For many bearings grease is considered better than oil, because it can be compressed in its cup, giving a more positive feed, and should the bearing warm up, the viscosity of the

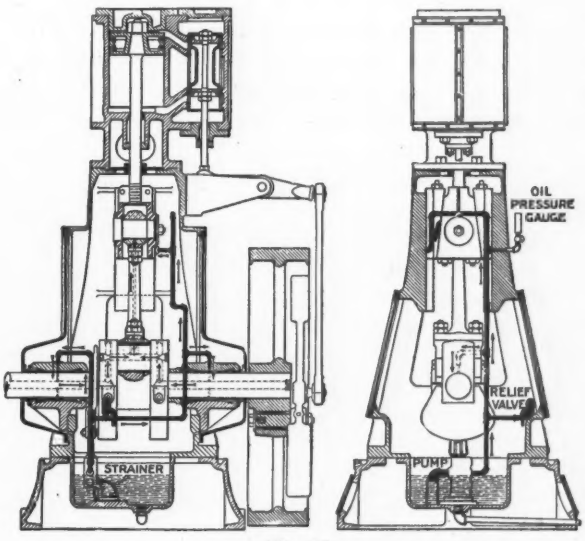


Fig. 10

grease becomes less, thus allowing the journal to be flooded and coefficient of friction decreased. It should be fed to the bearings by means of compression cups, either of the spring or weighted type. A form of cup generally used is shown in Fig. 8. The oil is packed in the reservoir and a piston which fits

in the interior is made to press down upon the top of the grease by means of a spring which is regulated by a set screw on the top of the cup.

Besides being used for bearings, grease has a very wide

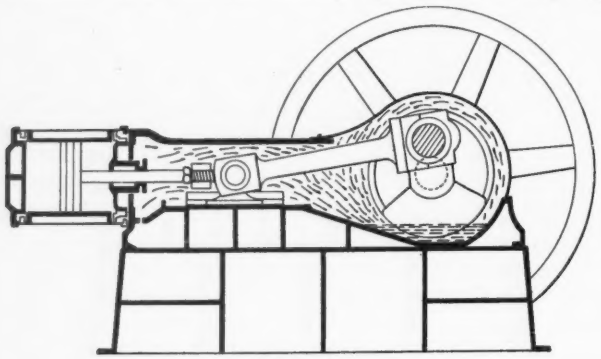


Fig. 11

use for heavy pressures, such as for the bearings of street railway motors and car axles, for coating wire ropes to prevent wear, for rolling machinery, for lubricating the teeth of the gears and the like, in which case they are generally applied by hand when needed.

Owing to the great care which the many oil cups require around a power station and the damage which might occur in case any one of them should not feed properly, has led to the use of oiling system, which insures a steady feed of oil with the least amount of attention. Fig. 9 shows a system which is used extensively. The oil is fed to the different bearings by gravity from the overhead oil reservoir, and after passing through the bearings, it is piped to the oil filter or filters in the basement, and after being purified it is again pumped to the reservoir, making the process automatic and requiring only slight attention. The flow of oil is continuous and a liberal supply can be used in all the bearing without loss. It is of the utmost importance in a system of this kind that the filtered oil be free from grit and dirt, otherwise the oil cups or feed pipes would become clogged up with grit or dirt, so that an oil filter is necessary. The dirty oil from the bearings

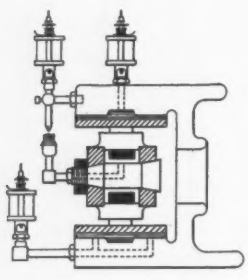


Fig. 12

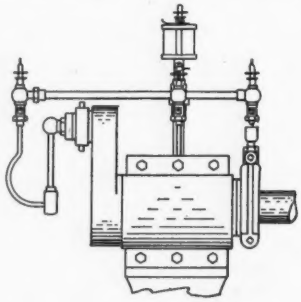


Fig. 13

enters the top of the filter and after being filtered, is pumped to the overhead tank for use again.

Realizing the many advantages of an automatic oiling system, many engineers have incorporated an oiling system for each individual unit which they build. The oiling system used on the Sturtevant engine is shown in Fig. 10. A submerged oil pump, operated by the crank shaft, draws oil from the reservoir and forces it through pipes and internal passages in the moving parts to the crank pin, the wrist pin and main bearings. At the end of each stroke, the pressure of the pump overcomes the pressure on the bearings and a fresh film of oil is forced between the bearings. The pressure per square inch to maintain this film of oil is from 10 to 20 pounds per square inch. The frame of the engine is enclosed and centrifugal oil guards are located on the shaft where it passes through the casing so that no oil can escape, which insures cleanliness and continuity of pumping. Water from the piston rod stuffing box is prevented from mixing with the oil by the use of a watershed partition. An oil pressure gauge outside the engine indicates the condition of the oiling system and a strainer is located near the pump for the purpose of preventing any foreign particles from entering the system.

A modification of this method, and one which is widely used for horizontal high speed engines, is shown in Fig. 11. The frame is of the enclosed form and an oil-tight hood is fitted over the top of the engine. The revolving crank discs with their peripheries dipping in the oil, spray continuously the guides and the whole interior of the bed. In this way lubri-

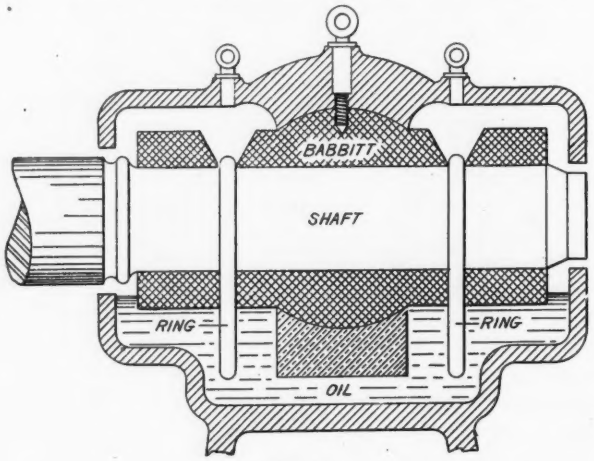


Fig. 14

cant is supplied to an oil cup on the cross-head, which feeds the wrist pin through a hole in the pin itself. A vertical duct in the end of the rod also leads to this part and two interior frame pockts are likewise filled with oil and communicate through large passages directly with the main bearings. After passing through these bearings, the oil is caught and returned to the crank pit. The crank pit receives its oil from the pit through straight ducts of ample dimensions.

In plants or engines where force-feed is not in use, some special oiling device is generally used for oiling the crank pin and cross-head pin. Fig. 13 represents an oiler for oiling the crank pin and eccentric. The tube through which the oil flows by centrifugal force to the crank pin, is bolted to the end of the crank pin and is half of the stroke of the engine in length.

One type of cross-head pin oiler is shown in Fig. 12. The oil flows from the oil cup and is wiped off each stroke, the oil flowing to the center of the cross-head pin and thence to the bearing.

The development of the electric motor and dynamo and high rotative speeds, has brought about the use of the self-oiling bearing shown in Fig. 14. It consists of an ordinary babbitted

bearing surrounded by a large oil chamber. Equi-distant from the ends, there are openings in the bearing through which metal rings are made to travel by contact with the journal. The lower side dips into the oil in the reservoir and conveys it to the top of the bearing where it is distributed along its length, after which it flows between the wearing surfaces back into the reservoir. The body of oil in the reservoir is so great as compared with that used on the journal at one time, that the journal can be run a very great length of time without the temperature rising.

ENGINEERING IN A NUTSHELL

Answers to Questions That Won First Prize in the Michigan N. A. S. E. Contest

By Edward J. Rose.

Subject No. 9.—Selection of Boiler Feed Apparatus.

In the selection of a boiler feed pump absolute reliability must be the first consideration after deciding the proper size for the work to be done. When the question of economy is considered, and also the advantage of fewer parts, the steam wasted in the eight parts in a duplex pump is enormous, so an outside-packed plunger type is favored by many engineers for hot-water boiler feed. The pump should be selected to run at a moderate speed and reserve power should be considered.

The machine should be simple and yet not lacking the essential parts of a perfect pump, and should be ready to start at any point of the stroke. The valve motion should not be complicated, and the construction should be the very best of material and workmanship. The water cylinder lining, valve seats and piston rods should be the best phosphor bronze, so they will not corrode. The pump cylinders should be provided with removable lining that can be easily taken out for reboring or exchange. In regard to the necessary size, it is sufficient to say that all manufacturers have tables giving the piston speed and capacity in gallons per minute, from which data the proper size may be found at once.

Do not have piston speed exceed 50 feet per minute for boiler feed pumps. Duplex pumps are more in use than single-acting pumps. The flow of water is steadier and the piston speed may be slower for the same velocity of flow.

A duplicate feed pump should always be held in reserve in case of accident to the regular pump, or an injector, that interesting appliance and faithful friend of the steam plant; peculiar in its action to the uninitiated, and yet simply an instrument for allowing steam to rush and to suck up and mix with itself a stream of water by which it is condensed and imparts its own velocity that the combined mass of water and condensed steam enters into and feeds the boiler.

The exhaust steam injector is another boiler feed auxiliary, and the most economical boiler feed known, and is deserving of more consideration from engineers who wish to run their steam plants with economy.

The power pump is another very economical boiler feed; far more so than the steam pump, and should be put in if the plant is run continuously; but even in that case it will be well to put in one of the above mentioned as an auxiliary to it.

Subject No. 10 Economy in the Steam Plant.

If it were possible to secure data of the different performances of a large number of steam plants, they would indicate the way in which we could secure better results from the plants we are in charge of. Many practical engineers handling a steam plant, devote themselves particularly to getting best results from one special thing. Instead of doing this, he should (if he wishes to run his plant with economy), give his attention to all things pertaining to it, so the first thing to do is to find out the losses. Some are caused by poor draft, leaky chimneys, leaky boiler walls, too much grate surface, incomplete combustion, too high or too low steam pressure, or overloaded or underloaded engine, machinery and shafting out of line, hot bearings, too little lubrication, tight packing, leaky joints, bare steam pipes, an exposed engine or boiler, reciprocating pumps and feeding the boiler irregularly.

These losses must be checked if the best economy is to be attained. The flue gases alone may run up to 40 per cent less at a temperature of 800 degrees and excess of air of 150 per cent, so some means must be made to utilize this loss of heat. A high furnace temperature is most essential and this is best secured by good draft. The flue gases should be recorded so as to enable the engineer to find out if there is any waste in the flue gas temperature or an excess of air. It is rare that just the right amount of air is admitted and there is a loss when the amount is too little or too great. So it is very essential that the flue gases should be regulated to the best economical conditions. Keeping the steam pressure regular is not only economical but the wear and tear of the engine is lessened by the more regular cut-off. An Automatic damper would be a benefit and a paying investment.

An overloaded engine has no chance for economy and the only remedy is one with sufficient capacity at an economical cut-off point. In an underloaded engine there is a great loss in cylinder condensation. It would probably pay to reduce cylinder diameter by bushing it until such time that the load will increase so that the bushing can be removed.

In order to investigate further the possibilities of improving the economical conditions of the steam plant, the indicator should be applied to the engine, and the power required for operating the whole plant and the different parts determined. The amount of power consumed in overcoming the friction in line shafting would be a surprise to many. As a result, changes would be recommended, such as correcting the alignment of shafting, cleaning and rebabbitting line shaft bearings and the proper amount of lubrication. The writer had one case in particular, where 21 horse power was saved out of a total of 97 horse-power friction load. Arrange the lubrication so that the oil can be used over and over again, and an abundance should be given engine and shafting. Of course a good oil filter should be used and even the oil in the wiper rags and waster should be extracted and put through the oil filter. Save the oil and use waste and wiper over and over again.

Incidental savings would follow also, such as having all bare steam pipes covered so as to avoid all losses due to condensation.

No live steam should be used for heating purposes if exhaust

steam can be used without putting too much back pressure on the engine. The heat in the exhaust, which would be wasted if not utilized in this way, amounts to not less than 80 per cent. of the heat entering the engine in the live steam, so it can be passed through the hot-water heater on through to the heating system. If the resistance is too great by the gravity system, then a vacuum system put in would relieve it of any back pressure.

As the aim is to attain the highest possible economy in the operation of all parts of the steam plant, the engineer should have such appliances as a water-meter, a platform scales, hot water thermometer and draft gauge. With these a daily record can be made in a systematic way, also a record of work done, which enables the engineer to know very closely any change that may take place. With a good system, the engineer, if he has men under him, should have each man responsible for his portion of the work. Evidences of good economical methods on the part of the chief engineer soon lead to similar characteristics in the men under him. The result will not only lead to the economical running of the plant, but it will materially lighten the labors of all concerned.

SUBJECT NO. 11. SETTING UP, ADJUSTING AND RUNNING THE CORLISS ENGINE.

In setting up the Corliss engine, after an approved foundation has been completed, great care must be taken when putting the different parts together that they are perfectly clean from grit and dust, and after the frame, cylinder and outboard bearing are in place and level, the next thing to do is to line up. Fasten a board across the flange of the cylinder and get the center of cylinder bore. Erect a standard at the crank end of engine, fasten the end of a very fine line or wire, sufficiently strong to be drawn tight without sagging, to a stick about two or three inches long and draw it through the hole in the board, which is fastened across the cylinder flange, through the cylinder and stuffing box and finally through the hole in the standard. After drawing it tight, fasten the other end to a similar stick so it will be held in position. Now with a stick or wire rod cut to the exact length of one-half the cylinder diameter in the counter bore, center the line at the head end of the cylinder. The line can easily be moved into the desired position by shifting the small stick to which it is fastened. After this end has been perfectly adjusted, center it in the same manner with the stuffing box. To move it in position on this end the stick on the standard has to be adjusted until the line is perfectly central with the stuffing box. This line is the center line of the engine and all other parts have to be adjusted to it. So too much care cannot be taken for this particular adjustment.

The next part to be adjusted is the shaft. This may be adjusted at right angles with the line and be leveled by placing the level on the shaft. The line should cross the crank pin when the shaft is in its proper position at the middle point of the length of the pin, and when the shaft is turned over the same point should touch.

The guides should next be tested. This is done by measuring with tram or caliper from the line to the face of the guides at each end. Should they be out of line the construction of the engine will have to govern the changes necessary to bring them in line.

The majority of main bearings in large engines are made with quarter boxes adjusted by means of set screws and head blocks and by wedges and hook rods. When adjusting the quarter boxes, each nut should be turned a little at a time so as to insure the wedge being drawn up squarely; otherwise, the pressure against the shaft will be unequal and heating will result.

In erecting a Corliss engine it is always advisable to have the contractor furnish the services of an expert erecting engineer; the purchaser to furnish all necessary labor. The operating engineer should be with the erecting engineer, so as to notice all the details of the construction, particularly in valve mechanism. It is the valve gear that furnishes the most interesting features to the practical engineer.

The adjusting of the Corliss engine valves, sometimes called detachable valve gear, should next be undertaken. The direct action of the working parts of the engine opens the valves at the proper time, and keeps them open until the connection with the engine is detached and the hook tripped by the working of the cut-off cams. The eccentric works the valves which are connected by means of the wrist-plate, carrier-arm, rocker-arm and reach-rod. To adjust the valves, the reach-rod, which connects the wrist-plates with the rocker-arm, must first be unhooked. Next place the wrist-plate in its central position and hold it there. All the connecting rods between the steam and exhaust valve-arm and the wrist-plate are made with right and left-hand threads on their opposite ends, and furnished with jamb-nuts, so that the rods can be easily lengthened or shortened by merely slacking the jamb-nuts and turning the rods.

In this manner set the steam valves so that for every 10 inches diameter there will be ¼-inch lap and for every 32-inch diameter—½-inch lap. Other intermediate diameters in proportion to these distances. Set the exhaust valves for every 10-inch diameter of cylinder with 1-16-inch lap, and for 32-inch diameter ⅛-inch lap. Double these distance for condensing engines. The lines on the valves which are nearer the center of the cylinder than the lines on the valve chambers, show the lap on both steam and exhaust valves.

After the valves have been thus adjusted, turn the wrist-plate to the extreme limits of its throw and adjust the rods connecting the steam-valve arms with the dash-pots so that when the rod is down as far as it will go, the square steel block on the valve-arms will just clear the shoulder of the hook.

The adjustment of these connecting rods must be properly made. If too long the steam-valve arm will be bent or broken, and if too short the valve will not open, because the hook will not engage. Now hook the engine in, loosen the eccentric on the shaft, and turn it over, adjusting the eccentric-rod so that the lines on the hub of the wrist-plate, which show the limits of its travel and throw, will coincide with the line scribed on the stand. Place the crank on the dead center and turn the eccentric in the direction which the engine is to run, so that the steam-valves will show an opening of 1/32 or ⅛ inch (depending on the speed the engine is to run—the faster the speed the more lead it requires).

The line on the valve, which is nearer the cylinder than the line on the valve chamber, shows the opening required, which is the "lead" or port opening when the engine is on dead center. Now, secure the eccentric on the shaft, by tightening the set screw and throw the engine over to its dead center, carefully

noting if the other steam valve shows the same opening or lead. If it does not, adjust it by lengthening or shortening the connecting rod from the valve-arm to the wrist-plate. The exhaust-valves are adjusted in the same manner. These directions are for the half-moon style of valve gears which open from the center of the cylinder.

In cases of the crab-claw or any other style which open towards the center of cylinder, the method of the adjustment is the same as given above, but with the difference that the lap on the steam valves will soon be shown when the line on the steam valves is nearer the end of cylinder, and the lead when the line is nearer the center of the cylinder than the line on the valve chamber.

In adjusting the rod connecting the cut-off or tripping cam with the governor, the governor must be at rest, and the wrist-plate at one extreme of its throw or travel. First adjust the rod connecting the cut-off or tripping cam on the opposite steam valve so that there will be 1-32-inch clearance between the cam and steel on the tail of the hook. Throw the wrist-plate to the other extreme of its travel and adjust the cam for the other steam-valve in the same manner. Now, block the governor up 1¼ inch, which will be its average distance when running. Hook the engine in and turn slowly in its running direction and mark the distance the cross-head travels from its extreme position of dead-center when the cut-off cam trips the steam-valve. Continue to turn engine slowly past the other dead-center and mark the distance of the cross-head from its extreme of travel when the steam-valve drops. If the distance is the same in both cases, the cut-off is equal and the adjustment is correct. If not, adjust one or the other of the rods until this is so.

The work of centralizing the position of the various parts and equalizing the movements, and setting and adjusting, are practically the same with the angle and double eccentric engines.

Now, in operating or running the Corliss engine, the engineer should be vary careful to notice that the gag-pot is full of oil and always that the dash-pots drop properly. It is always a good idea to have some kind of a jack nearby so if the dash-pots drop they can be lifted immediately, and always watch that the valves are cutting off alike.

Suppose the valve-stem of the steam-valve should break, what could be done to prevent a shut-down? The valve with the broken stem should be turned to cover the steam-port and blocked in this position, then disconnect the exhaust valve on the same side and turn the valve so as to be constantly open. The engine will then run single acting but with half the power.

Particular care must be taken with the governor belt. If it becomes oily there is great danger, as it will allow a longer range of cut-off than is necessary to care for the load, in which case the engine will speed up to the danger line. To avoid trouble by the piston striking the heads, have striking points marked plainly on the guides, so that when keying up the clearance is always indicated by the distance between the line of dead-center and striking point.

Subject No. 12. Single Phase Current for Railway Systems.

While the applications of electric power have appeared in many useful ways, there is probably no direction which has been made more apparent to the general observer than the development of electric traction for interurban service. The three systems in general use are the direct-current, three-phase and single-phase systems, but from a practical standpoint each of them lacks some desirable feature. The direct-current system requires low train voltage and expensive sub-stations. The three-phase system makes two trolley wires necessary and it is very sensitive to voltage changes. The single-phase system possesses difficulties with the commutator and has low efficiency but has the advantage of simplictiy and the use of higher trolley voltage. It is becoming a strong competitor of the direct current system, as single-phase equipments may be arranged to suit both long and short lines.

According to data obtained by the American Institute of Electrical Engineers, in showing where the three-phase and single-phase alternating current railway motors are now developed to a point where they fairly challenge the steam locomotives, even in long, hard freight service, the trolley and track losses average 3.9 per cent, the load factor being 0.33. These figures were obtained on a single-phase system forty miles in length, having a potential of 11,000 volts. The first single-phase railroad to be equipped for commercial service was on a stretch of track between Schenectady and Ballston Spa, N. Y.

With the introduction of this style of apparatus it will be possible to transmit electric power at high voltage to the cars and transform it by stationary transformers located directly on the cars, to a voltage suitable for use in motors. The motors have the advantage in that they can be used on direct current as well as alternating current for combination systems, and that the speed can be readily varied by the same devices that are used in direct-current practice.

This much is certain, alternating-current traction is highly desirable for much of the future railway work; it has already made progress enough to deserve serious consideration and to insure future growth, and finally, if the large experiments now under way, turn out well, single-phase current for railway systems will be pushed into very extensive use, both in new work and in the re-equipment of systems in which direct-current traction has been forced beyond its economical limits.

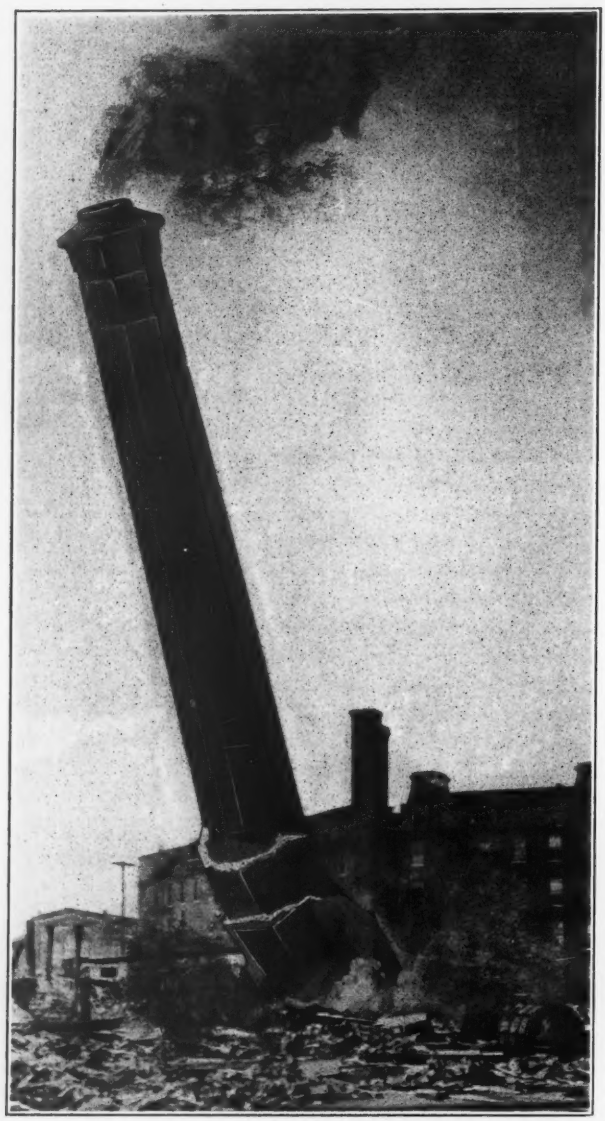
Fuel Cost of One Brake Horse Power Per Year

According to the figures of those who favor the use of the producer gas engine, the accompanying table has been compiled, which shows the comparative fuel costs for a brake-horse-power per year of 3,000 hours for various kinds of fuels, it being claimed that a producer gas engine will give a brake-horse-power on one pound of coal.

Type of Engine	Kind of Fuel	Price	Fuel per B. H. P. hour	Cost 1 B.H.P. per year
Gasoline Engine	Gasoline	16 Cents per gallon	1 Pint	$60.00
Gas Engine	City Gas	$1.00 per 1000 Cu. Ft.	18 Cu. Ft. per B. H. P.	54.00
Simple Steam Engine	Coal	$4.00 per ton	8 lbs.	48.00
Compressed Steam Engine....	Coal	$4.00 per ton	4 lbs.	24.00
Natural Gas Engine.....	Natural Gas	30c. per 1000 Cu. Ft.	12 Cu. Ft. per B. H. P.	11.00
Producer Gas Engine.....	Coal	$4.00 per ton	1 lb.	6.00

Demolishing a Brick Chimney

The erection of a large brick chimney calls for considerable skill in its design and construction, and under certain conditions the demolition of a large chimney requires considerable ingenuity in order to prevent it from falling and injuring adjacent properties. The accompanying photograph represents a 125-foot chimney, which is falling as a result of well-designed plans. It was located on the site of a large worsted mill which



Snapshot of a Falling 125-Foot Chimney

was torn down to make room for a boulevard which is being cut through the heart of Philadelphia.

To prevent the chimney from falling in the direction of the nearby railway tracks or against adjoining houses presented difficulties that were not easily overcome. Bricks from the base were removed on three sides and large timbers substituted. The side facing the railroad tracks was left intact so that it would fall in the direction where no damage would be done.

The timbers supporting the chimney were then soaked in oil and set on fire. As the fire ate its way through the wood the stack began slowly to careen until it reached an angle of about 15 degrees when it broke 20 feet above the ground and came down with a noise that could be heard for half a mile. The chimney was built 27 years ago and was erected at a cost of $8,500, there being about 120,000 bricks used in its construction.

———o———

Location of Fusible Plugs.

Among the rules recently issued by the Board of Boiler Rules of the State of Massachusetts are those relating to the fusible plug. According to these rules, fusible plugs must be filled with pure tin, and the least diameter shall not be less than one-half inch, except for working pressures over 175 pounds gauge, or when it is necessary to place a fusible plug in a tube; in which cases the least diameter of fusible metal shall not be less than three-eighths inch.

The location of fusible plugs shall be as follows:

1. *In Horizontal Return Tubular Boilers*—In the back head, not less than two inches above the upper row of tubes and projecting through the sheet not less than one inch.

2. *In Horizontal Flue Boilers*—In the back head, on a line with the highest part of the boiler exposed to the products of combustion and projecting through the sheet not less than one inch.

3. *In Locomotive Type or Star Water-tube Boilers*—In the highest part of the crown-sheet and projecting through the sheet not less than one inch.

4. *In Vertical Fire-Tube Boilers*—In an outside tube, placed not less than one-third the length of the tube above the lower tube-sheet.

5. *In Vertical Submerged-tube Boilers*—In the upper tube-sheet.

6. *In Water-tube Boilers, Horizontal Drums, Babcock and Wilcox Type*—In the upper drum, not less than six inches above the bottom of the drum and projecting through the sheet not less than one inch.

7. *In Stirling Boilers, Standard Type*—In the front side of the middle drum, not less than six inches above the bottom of the drum and projecting through the sheet not less than one inch.

8. *In Stirling Boilers, Superheated Type*—In the front drum, not less than six inches above the bottom of the drum, and exposed to the products of combustion, projecting through the sheet not less than one inch.

9. *In Water-tube Boilers, Heine Type*—In the front course of the drum, not less than six inches from the bottom of the drum, and projecting through the sheet not less than one inch.

10. *In Robb-Mumford Boilers, Standard Type*—In the bottom of the steam and water drum, twenty-four inches from the centre of the rear neck, and projecting through the sheet not less than one inch.

11. *In Water-tube Boilers, Almy Type*—In a tube directly exposed to the products of combustion.

12. *In Vertical Boilers, Climax or Hazelton Type*—In a tube or centre drum, not less than one-half the height of the shell, measuring from the lowest circumferential seam.

13. *In Cahall Vertical Water-tube Boilers*—In the inner sheet of the top drum, not less than six inches above the upper tube-sheet.

14. *In Scotch Marine Type Boilers*—In combustion-chamber top, and projecting through the sheet not less than one inch.

15. *In Dry-back Scotch Type Boilers*—In rear head, not less than two (2) inches above the top row of tubes, and projecting through the sheet not less than one (1) inch.

16. *In Economic Type Boilers*—In the rear head, above the upper row of tubes.

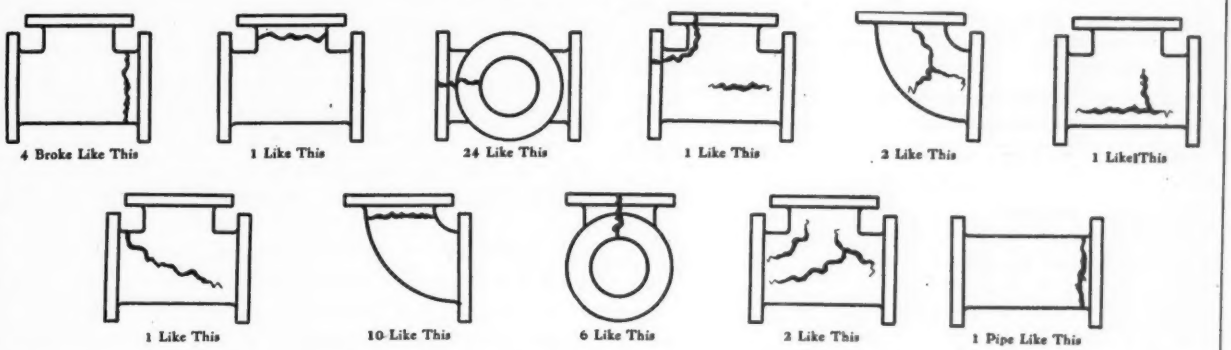
17. *In Cast-iron Sectional Heating Boilers*—In a section over and in direct contact with the products of combustion in the primary combustion chamber.

18. For other types and new designs, fusible plugs shall be placed at the lowest permissible water level, in the direct path of the products of combustion, as near the primary combustion chamber as possible.

The Bursting Point of Flange Fittings.

According to the *Valve World,* a number of destructive tests which were made on pipe-fittings, resulted in their bursting in the manner shown in the accompanying illustration. As a result of these tests, the following rules are proposed for obtaining the bursting-pressure and thickness of flange-fittings:

Of Fifty-two Fittings and One Piece of Pipe Tested to the Bursting Point by Hydraulic Pressure the Following Results were Obtained:



Thickness of body being known to determine the bursting point

$$B = T \times S \div D.$$

T = thickness of metal;
D = inside diameter;
B = Bursting point;
S = 65 per cent. of tensile strength up to 12 inches diameter; larger sizes use 60 per cent.

For working pressure, divide result by factor of safety of 4 to 8.

Bursting point being given to determine thickness of metal

$$T = B \times D \div S.$$

If the fittings are made of ferro-steel, 33,000 pounds per square inch may be taken as the tensile strength, and for cast-iron, the tensile strength will average about 22,000 pounds per square inch.

Boiler Explosion in the Allentown Plant of the American Wire and Steel Co.

One of a battery of twelve boilers exploded in the mill of the American Steel and Wire Co., Allentown, Pa., shortly after 3 o'clock on the afternoon of December 9th. As a result of the explosion, which shook the entire city, three men were blown to pieces and seven others were injured. The boiler was of 200 horse-power capacity and it exploded without any warning. In its flight it tore through the roof of the boiler house and broke into two parts, one part tearing through the drawing mill, wrecking thousands of dollars worth of machinery, the other part, clearing all obstructions to its flight, landed in the Iittle Lehigh River adjoining.

The boiler was eight years old and was regarded as absolutely safe. The surviving firemen say it was not due to low water. Exoneration for everybody was the verdict of the Coroner's jury which investigated the cause of the explosion.

First International Congress of the Refrigerating Industries.

The first international congress of the refrigerating industries will be held in Paris, France, in June, 1908, under the patronage of M. Ruan, Minister of Agriculture, and the Ministers of Commerce and Industries of the French Republic. Every organization connected with the refrigerating industry all over the world has been invited to send delegates to this congress, and it will be the most important event ever held in connection with the application and production of artificial cold.

The topics to be considered are Low Temperatures and their general effects, Refrigerating Appliances, the Application of Refrigeration to Food, the Application of Refrigeration to Other Industries, the Application of Refrigeration in Commerce and Transport, and Refrigeration Legislation.

The program of the sessions of the Congress include a discussion of the above topics, public conferences, excursions, fetes and receptions. English, French, German and Italian will be the official languages and papers may be submitted in any of these languages.

Any information about the details of the congress can be had from Theodore Kolischer, Chairman of the Committee on Transportation, Baily Bldg., Philadelphia, Pa., or J. F. Nickerson, secretary of the American Committee, 315 Dearborn St., Chicago, Ill.

Lignite coal has been successfully used on mechanical stokers by the Denver City Tramway Company for several years, and it is said that better combustion has been obtained than with hand-fired coal, resulting in a saving of about 25 per cent. in the cost of the fuel.

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In Memory of Lord Kelvin; the Great Scientist.

The whole scientific world is mourning the loss of Lord Kelvin, better known as Sir William Thompson, who died at his home in England, on December 17th. His death is not only felt keenly in his native country, but throughout the whole civilized world, because of his labors which were devoted to the discovery of scientific facts that have meant so much for the advancement of civilization. Born in Belfast, Ireland, on June 26, 1824, he was educated at the Glasgow University, and at a very early age he exhibited the ability which has since made him famous. At the age of 22, he became professor of natural philosophy, a chair which he filled until 1899.

While his achievements as a physicist have been many and varied, it is for his work in the field of electricity, for which he will perhaps be longest remembered. Beginning with his work on the first Atlantic Cables, there are few departments in the science of electricity that do not bear the impress of his mind. In 1867 he was knighted by his country for his work in connection with the Atlantic cable and in 1892 he was made Lord Kelvin. He was the designer of one of the earliest practical alternating current dynamos, and when there was first talk of utilizing the water power of Niagara for the development of electrical energy, it was Sir William Thompson who was made chairman of the advisory board that took the matter under consideration. His work in connection with electricity also led him to produce instruments for the measurement of every electrical quantity, and when electric lighting came to the front he produced a new set of instruments to meet the needs of the electrical engineer. Currents from the smallest fractional part of an ampere to the largest amount produced, and pressures from the minutest decimal of a volt to 100,000 volts come within the range of his instruments; while the consumption of power is easily recorded by means of his well-known wattmeter. The compensation of magnetism in the mariner's compass, a deep sounding device and a tide guage are among his many achievements.

Perhaps the greatest event in his life took place in 1896 when he celebrated the 50th anniversary of his professorate at the University of Glasgow. It was attended by delegates and visitors from every corner of the globe, and some remarkable feats in telegraphy were shown at that time, one of which was the sending of a telegram 20,000 miles in 7½ minutes.

Despite his many achievements and the hundreds of honors which were thrust upon him, he was the most modest of men. On the occasion of his golden jubilee, he made this modest statement: "One word characterizes the most strenuous of the efforts for the advancement of science that I have made perseveringly in the last fifty-five years and that word is failure. I know no more of electrical or magnetic force, or of the relation between ether, electricity and ponderable matter, or of chemical affinity, than I knew and tried to teach to my students fifty years ago in my first session as professor."

It was such remarks as these that showed what a learned man he was, for every man, who is truly great in scientific research, realizes how little is even yet known of the world's great forces and his remarks are in striking contrast to the pompous attitude assumed by some comparatively ignorant men.

It is said that if a man wishes flowers on his grave he

must plant them himself; certainly Lord Kelvin planted the seed which will grow for centuries after the garlands, which have been placed on his grave by his friends, have withered.

—o—

The Utilization of Alcohol for Fuel.

While every indication seems to point that alcohol will be used extensively for fuel in the future, there has not been much progress made in the past six months either in the manufacture or use of tax-free alcohol. At present there is only one large manufacturer of denatured alcohol in this country, but a number of other concerns are about to start its manufacture in large quantities and a small army of farmers are preparing to convert their corn-cobs, corn-stalks, refuse apples, cabbages and other waste vegetable material into alcohol under Government restrictions.

The principal restriction upon the wide use of alcohol has been the lack of apparatus in which to use it, as the clear white fluid cannot be employed as a fuel or as an illuminant in the same apparatus that is suitable for oil, so that special devices are being invented to gasify the liquid so that it can be used economically.

For general use, it is expected that lamps, stoves, etc., will largely use denatured alcohol, not only on account of the increased heat which a given quantity will give out, but also because it does not give out the disagreeable smell so prevalent with kerosene and gasoline. At the present price of about 30 cents a gallon, alcohol, of course, cannot compete with other liquid fuels, but with the price about 15 cents a gallon, it is expected to become a considerable factor, it being sold for about 12 cents a gallon in Germany, where it is being manufactured extensively from potatoes.

With the use of a proper carbureter the alcohol motor may be used for all purposes for which the gas and gasoline engines are now adaptable, although preliminary tests of the U. S. Government which were made at Jamestown have shown that gasoline is one and one-half times more economical than alcohol. This may be due to the fact that the proper form of carbureter has not yet been designed to give economical results.

With Yankee ingenuity at work and the price of alcohol reduced, it may be expected that the year 1908 will show real progress in the utilization of this clean hydro-carbon liquid, the combustion products from which yields only carbonic acid and water.

—o—

Imaginitis

Hardly a day passes that some newspaper in some part of the country does not publish, with photographs of the inventor, a description of a perpetual motion machine of one kind or another; or of some device which gives out more energy than is put into it. While the patent office will not grant a patent for a perpetual motion machine, the records there show hundreds of devices which are patented, the proud possessor of which, however, has nothing more or less than a good case of imaginitis.

Were it not for our inventors, however, there would be very little doing in the progress of the mechanical world and to many of them, who have burned the midnight oil and who have devoted their life to study and investigation, the high state of mechanical efficiency of our many industries are due.

There is, however, a decided distinction between an inventor who, for instance, tries, by his inventions, to burn ashes and one who devotes his time and energy to getting all the heat out of coal before it is reduced to incombustible. There is also some marked difference in the attitude of one who tries to get 120 per cent. efficiency from an electric generator and one who is striving to perfect the arrangement of field and armature so that as high as 95 per cent. or even better can be obtained for utilization of power.

One of the most ingenious systems for getting more power from a machine than is put into it has been called to our attention during the past few months by the inventor himself and although he decries the very thought of perpetual motion, he claims that twenty horse-power may be obtained for every five or six horse-power put into his apparatus. His method for doing this is to use an elaborate system of fly wheels connected to four prime movers, the arrangement being that each prime mover will be connected to the power shaft three-fourths of the time, the other one-fourth being used to allow it to run away and gain momentum so that when the clutch is thrown in, this momentum will be utilized to run the shaft and "coldly outweight" the heat power in the engine cylinder.

The whole scheme of clutches and fly wheels is neatly worked out and while the inventor admits that his machine absorbs ten times more power from friction than any other machine ever built, yet he claims that the momentum gained in the large mass of moving fly-wheels is not only more than enough to overcome this friction but the power in each set of wheels, due to the enormously large masses moving at high velocity, is more than is indicated on the indicator cards obtained from the cylinders of the engines.

Unfortunately, a half a dozen of these machines, which have been built to amaze the engineering world, have been destroyed for one reason or another, so that all the inventor really has left at the present time is an iridescent dream in which he believes that energy is like a soap bubble, it growing larger and larger at will.

There are a number of diseases which end in "itis" and we cannot diagnose a case of this kind any better than to call it a bad case of imaginitis.

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Wiring for Central Stations.

Rubber-covered cable is recommended in all cases of station wiring, as it will not be affected by dampness. All cables should be mounted on porcelain insulators, unless they are run in conduits. Crosses should be avoided as far as possible and nothing should be used but the highest grade of rubber-covered wire. In all cases the Underwriters' rules should be followed carefully. Alternating wire with high voltages should be carefully laid out and installed. Where a potential higher than 2,500 volts is to be used certain special precautions should be observed in the placing of insulators, distance between wires, etc. All cables inside a station should have a capacity of at least 1,000 circular mils per ampere. Equalizing cables should have at least a capacity of 1,500 circular mils per ampere of the total full load current of the smaller generator if two generators are used, and of the largest generator if more than two generators are to be connected in parallel.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Governor Trouble May Cause Pump to Race

EDITOR THE PRACTICAL ENGINEER:

In answer to the cause of the pump racing, as described by A. D. P., I would say that it is most likely to be caused by the governor, the stem of which is very frail and which may have become bent. The weighted lever on the governor may be on the wrong end, although the sketch does not show it that way in the December issue. The weight may be also placed too far out on the lever, which will cause trouble by preventing the valve dropping. The pump should also receive cylinder-oil above the governor, so that both the governor valve and pump will be lubricated. G. E. W.

East Bridgewater, Mass.

Vacuum Causes Pump to Race

EDITOR THE PRACTICAL ENGINEER:

In reference to A. D. P.'s pump trouble, I would say that I have the same kind of pump on my heating system and it would race the same way if I didn't throttle it down before I shut the steam off. When A. D. P. shuts the steam off, the steam remaining in the pipe condenses and puts the system under a vacuum which holds the water up in the receiver of his pump, so that the automatic valve stays open when the float is held up by the water, and consequently the pump makes a terrible racket by running short-stroke. I also have air-valves in the system, and also a vacuum breaker, but these do not help any when the water is held up under it, because it keeps the breaker shut. H. M.

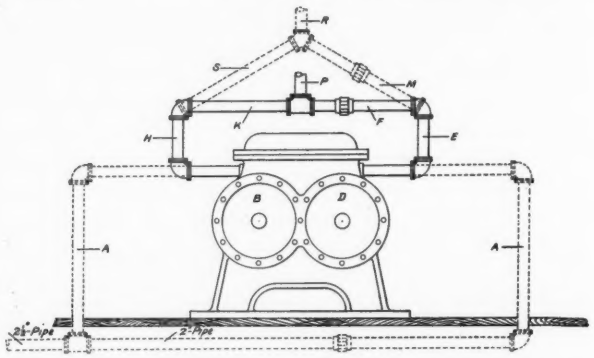
Fall River, Mass.

Exhaust Piping for Pumps

EDITOR THE PRACTICAL ENGINEER:

In reference to L. C.'s pump question, I would like to submit the accompanying sketch and suggestions. With the exhaust arrangement, as shown by L. C., the cylinder D would exhaust through the pipe EF. The natural course of this exhaust steam would be on through K, causing some compression in pipe KH. Cylinder B would then exhaust and would have to overcome the compression formed by the exhaust of cylinder D, and the steam would then be forced back into pipe FE. While the steam must finally exhaust through pipe P, I think that it can be seen that if it were cream instead of steam, a hoe would be needed to extract the butter formed by this churning.

If L. C. were to use my suggested plan, shown by the upper dotted lines, the cylinder D would exhaust through pipe EM. The steam would strike the Y, which would give it an upward motion, forming a partial vacuum in pipe HS, which would have a tendency to draw the exhaust from cylinder B instead of forming a pressure against it. It would improve the arrangement if pipe R were made larger than the others, unless the extra condensation caused by the larger pipe, and the fact that the force of the exhaust would be lessened, would have a tendency for water to collect and back up on the cylinder.



Exhaust Piping for Pumps

I prefer the method of carrying the pipes down on each side of the cylinder, as shown by the dotted lines AA. This does away with all possibility of water collecting in the cylinders. I have used this arrangement of connection for the exhaust pipes of my pump, the final exhaust pipe being ½" larger than the first pipes, thus causing a partial vacuum to be formed between the final exhaust pipe and the pump. B. L. K.

Albany, N. Y.

Exhaust Connection to Pumps. The Efficiency of Steam Separators

EDITOR THE PRACTICAL ENGINEER:

Answering two of the questions on page 28, of the November number, there is no advantage in giving the double-exhaust pipe connection, as shown by L. C., unless the area of the vertical pipe connected to the tee is equal to, or greater, than the combined area of the pipes connecting to the exhaust-valve chamber. If this vertical pipe is not larger than the other pipes there is a disadvantage, in that the steam is required to make two right-angle turns more than would be necessary if the vertical pipe connected directly to the first elbow from the connection to the valve-chest. There may be some peculiarity in the construction of the pump, however, that makes this double connection necessary.

F. L. P. asks for the efficiency of a steam separator. This depends altogether on the amount of water in steam. The more water present, the greater the amount of water removed by the separator, but the less its efficiency, if we figure efficiency as the degree in which dry steam is furnished from the apparatus. As an example, a separator may well show an efficiency of 100 per cent. where the steam is comparatively dry, so that its full capacity is not utilized in removing the small amount of water that must be separated. On the other hand, such an amount of water may come over with the steam that the separator is entirely filled with water, as is also the pipe leading from it to the engine cylinder, so that a great slug of water goes over to the engine, and the efficiency of the separator may be called zero. Although this is an unusual case, it is one that has happened more than once in the experience

of the writer. The thing for F. L. P. to do, in planning to install a separator, is to gauge the amount of moisture ordinarily brought over in his steam, and then install a separator amply large to take care of this amount of moisture. For all ordinary conditions the manufacturers of separators have figured out what is needed, and make their standard sizes ample to take the water out of steam supplied by a pipe of a given diameter. Thus separators are made in sizes to be used on steam supply pipes of a given diameter, and when one says, for instance, "a 5-inch separator," he means that this is a separator of capacity sufficient to remove all the water that would be carried over by steam flowing through a 5-inch pipe under normal conditions of operation, with some margin allowed for contingencies. I hope this may set F. L. P. and his employer on the right track in the separator business.

Rougemont, N. C. M. W. A.

Recess Cut in the Rod Will Prevent Stuffing-Box Trouble

EDITOR THE PRACTICAL ENGINEER:

The stuffing-box trouble described by R. C., of Chicago, in December number, is one which I have met several times and I have found other engineers up against the same trouble. The piston-rod is worn, perhaps, but slightly, but a wedge-shaped shoulder is formed at the end of the travel by wear, and the formation of rust and scale, and when the packing is closed up tight it is sufficient to break the gland. The permanent remedy is to have the rod trued-up and then turn a recess in the rod about a 1/16" and ½" wide, with the forward edge at the point of the former shoulder. It is for the same purpose that the counterbore is put in a steam cylinder. It will be obvious to every engineer that such improvement will not only prevent the breaking of glands but will stop the noise that is so frequently heard in the running of duplex pumps.

Louisville, Ky. E. S. H.

Combination Packing Will Cure Gland Trouble

In reference to R. C.'s gland trouble, I would suggest that if he cannot shut down to repair it, a temporary method of making repairs would be to use a good combination packing, which does not have to be screwed up as hard as square flax, and take the gland off and ream it so that it will have 1/16" clearance all around the rod, so that the packing will take all the strain if the rod does not run true. I think that will remedy it for the time being. H. M.

Fall River, Mass.

Stuffing Box Trouble Probably Caused by Rod Being Out of Center.

EDITOR THE PRACTICAL ENGINEER:

I note in the December number that R. C. has trouble with a packing-box gland of a duplex pump. Now, I am not going to suggest a remedy for his trouble, but simply give him a little of my experience along that line. My pump was of the single-cylinder type and was used for boiler feeding. The packing-box gland was round, and both belt holes on the water-end gland broke out. I turned the gland around and drilled new holes, but they went the same way. As a temporary repair, I took a piece of flat iron ⅜" thick, wide enough to form a strap over the gland, and after drilling holes for it to pass over the studs, I set the gland up with that.

It happened at this time that the pump needed a new cylinder-lining for the water-end, so I secured this lining, put it into place, replaced the pump, put on a new gland instead of the old one that had given me so much trouble, and the result was practically a new pump. The rod must have been out of center with the old arrangement and putting in the new lining brought it central again.

This may not be the cause of R. C.'s trouble, but I will say that I would use a better grade of packing than braided flax. I use the best piston-rod packing I can get, which is lubricated and lasts a long time. L. A. H.

Clinton, Iowa.

Sticky or Leaky Automatic Valve Causes Pump to Race.

EDITOR THE PRACTICAL ENGINEER:

In regard to A. D. P.'s receiver and pump trouble, I would say that the automatic valve either leaked or it sticks so that it does not shut off the steam when the water is lowered from the float; consequently the pump will continue to run, and from the fact that it is pumping no water at this time, and as there is no resistance to the steam-end, the result is that the pump gains in speed. I have one of the Dean single pumps connected to a homemade receiver, having a float made by a local tinner, which became filled with water and did not answer the purpose. When the pump takes the water out of the receiver it will run three times as fast as when it is handling water and delivering it in an open heater eight feet above the pump.

It will, of course, be understood that the remedy is to have the float and automatic valve in good working order; then the pump will stop when it drains the receiver.

Clinton, Iowa. L. A. H.

Method of Operating and Cleaning Water-Tube Boilers.

EDITOR THE PRACTICAL ENGINEER:

As I notice that most of the articles about boilers that are written in your paper pertain to the tubular type, I would like to give my experience with water-tube boilers. In the power house where I am employed, the boiler room is equipped with four B. & W. and two Stirling boilers of 300 horse-power each. Usually five boilers are fired and one is off for cleaning and repairs, and when the one boiler is ready for use it is fired up and the next one cut out. The plant has three engine rooms, the power house engine room being equipped with about 450 horse-power in engines, air compressors and pumps. The larger part of the steam, however, goes to one 30 in. x 48 in. and one 32 in. x 48 in. engine in the mill. These large engines are subjected to a very changeable load, and are sometimes loaded so hard that they are stalled with 150 pounds of steam behind them. This is very hard on the boilers, as they have to be forced for all that there is in them; in fact, the plant is about two boilers short. Therefore, with the sudden pull of the engines and the necessary hard firing, the water is often drawn away from the lower tubes, causing bags and blisters.

The feed water is pumped from a river into a reservoir and from that through an open heater to the boilers, and contains a very large amount of mud and scale-forming

matter. About two and a half years ago the superintendent decided to clean the boilers with compound which was obtained from a chemical company after making an analysis of the feed-water. At this time all six boilers were washed every two weeks and blown down every four hours, but the scale kept on increasing until the boilers were in the worst condition I ever saw. We kept on using compound for a year with no better results, until we got a new master mechanic, who bought two turbine cleaners, and with the aid of two good men produced excellent results. Five boilers are now fired, and they do one-third more work than the six dirty boilers. The boilers that are being fired are washed about every three or four weeks, and we have one boiler off for cleaning and repairing all the time. Our method of cleaning them, with some variations, is about as follows:

The boiler is cut out from the header and the fire pulled. All doors and dampers are left closed. The boiler is filled to the top of the glass and safety valve blocked open to blow down steam. The boilers stand this way about 36 hours, when it is quite cool. The water is run out and the tubes, drums and all brick work are washed down with the hose, which reveals any blistered tubes or bad firebrick, and it also helps to cool off the brick.

The steam drum and mud drum plates are then knocked in, and in the B. & W.'s all the front caps are removed and as many of the back caps as are leaking. The scale is drilled out with 150 to 180 pounds water pressure on the cleaner. Before starting to drill, all the tubes are inspected for blisters or defects, and are marked, thus saving some unnecessary drilling. After the tubes are drilled the drums are scraped or chipped and the circulating tubes drilled.

The water column is then thoroughly cleaned and the water alarm floats are renewed if necessary. The steam gauge, safety-valve, blow-off pipes, valves and brick work next come in for inspection, and the necessary repairs made. After new tubes are put in, the boiler is closed up and subjected to about 120 pounds hot water pressure in order to discover any leaky tubes or caps, and if all is O. K., a slow fire is started under it and the steam started in about three hours and the boiler is cut in as soon as the steam gets up to the pressure on the header.

It usually requires about two weeks to clean a B. & W. boiler in this manner; therefore they get cleaned about every three or four months, and the cost is no greater than with compound, and with the same amount of coal, the firm is turning out about one-half more work with one less boiler. But the boilers are being forced much beyond their rated capacity, and sometimes, after a very hard week's run, some of the bottom tubes are partly filled with loose scale, which I think is loosened by the sudden contraction caused by opening the fire-doors. The scale works down in the lower tubes and often causes a blister which, of course, means a new tube. The Stirling boilers are not affected in that manner, as their tubes are nearly vertical.

The Stirling boilers are cleaned in about the same manner but they are cheaper and quicker to clean and will stand more hard firing than the B. & W.'s, but they have a very bad habit of pulling the water over into the steam pipe, which, I think, could be remedied by the use of an extra steam drum or by a superheater. Our method of cleaning boilers may not fit other boiler rooms, as each one has its own peculiarities, but it is working sucessfully here, and after more boilers are installed it will work better.

Engineers, too often, use the indicator at the expense of the boilers, and while I am a great friend of the indicator and usually take a card or two about once a month, I think it is more economical to give the boilers a large share of attention. Some engineers are always striving for a perfect card and are making experimental changes, when the engine would run more quiet without the perfect card.

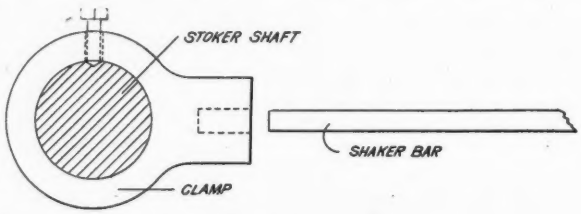
Another part of the plant that is sometimes neglected is the pumps. They are often placed in some dark, out-of-the-day place, where it is impossible to keep them cleaned and oiled. The basement is a good place for pumps, if it is clean, dry and well lighted, but sometimes it is better to have them in the engine room; or, better still, in a room by themselves, off from the engine room, where they can be more easily looked after by the engineer or oiler.

Elyria, O. J. H.

Clamp for Operating Mechanical Stokers by Hand

EDITOR THE PRACTICAL ENGINEER:

Any engineer who has charge of a Wilkinson mechanical stoker will find it convenient to have a clamp on hand, same as per sketch, which fits the rocker-shaft of stoker; or extend the shaft at one end of the stoker and have it square to fit a wrench, so that at any time, should the power give out, you can work the stoker by hand. My fireman's brains got thick



Clamp for Mechanical Stokers|

one morning and he didn't take time to drain the cylinder of the stoker engine, with the result that he put it out of business. It took several days to repair the engine, and by using the clamp as shown, I managed to keep the plant running until I got the engine repaired. One man can easily keep 3 stokers in operation by going from one to the other and giving the rockers a few shakes. But a clamp is needed on each stoker to receive the shaker-bar. G. O. B.

South Bethlehem, Pa.

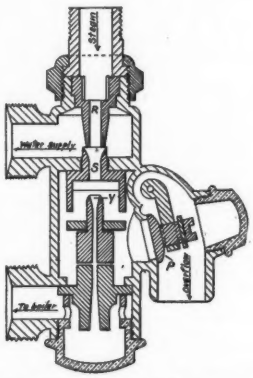
Vacuum in Injectors.

EDITOR THE PRACTICAL ENGINEER:

In a recent issue there was printed an article by H. A. Cozzens, in which he claims that there is a partial vacuum formed in an injector of the lifting type, but that there is none in the non-lifting type after they are in operation. In another issue C. J. W., of Groton, Mass., says there is no vacuum in any kind of an injector; he says that after the injector gets started it is all filled up with water. I beg to say that there is a vacuum in any and all kinds of injectors. Examining the interior of an injector,

R is the steam jet; S, the suction tube; Y, the delivery tube.

When the injector is started the steam goes through R and through suction tube S, and out through overflow, P. This causes a vacuum in the chamber or space around jet R; after the injector gets started, this space around jet R is filled full of water, but the space around the delivery tube



Illustrating the Formation of Vacuum in an Injector

is void of all pressure of any kind. If no vacuum existed around the delivery tube, the injector would not work. Mr. C. W. G. says he cannot find any place in an injector for vacuum, but if he will look at the sketch he will see that the space around the delivery tube is alowed for the vacuum.

E. W. K.

Cripple Creek, Col.

Canadian Examination Questions.

EDITOR THE PRACTICAL ENGINEER:

In reading Golden West's letter in the August number, a paragraph attracted me in which he states his belief that an examination for first-class licenses should cover a much broader field than they do. I have never noticed any published list of questions asked by examiners for first-class licenses in Canada and therefore such a list may interest your readers, the questions having been asked at an examination held only a few months ago.

1. Draw a theoretical indicator card of a high-class automatic cut-off engine, cut off ¼; revolutions per minute, 90; cylinder, 30" x 40"; spring, 60; boiler pressure, 125 pounds gauge.

2. Give diameter of crank shaft and crank pin for the above engine.

3. Figure the horse power of the engine and also the water consumption from the card.

4. What size surface condenser should be used for the above engine and how much condensing water would it require?

5. What size pumps would be required for the condenser?

6. Make a drawing of a 60" x 18' double riveted, butt seam, horizontal return tubular boiler. Show brick setting, method of supporting boiler and all necessary attachments for first-class practice.

7. Show the bracing necessary in the above boiler. State the number of braces required on each head and diameter of same. State the diameter of the tubes in this boiler and how many should there be?

8. What amount of grate surface should this boiler have, if Pittsburgh soft coal is used?

9. What style of governor should be used for the engine in question No. 1? Give your reason for same.

10. Describe how Corliss valves are set.

11. Describe how the engine foundation should be built and the best kind of material to use.

12. Describe how to rebore an engine cylinder, how to rebabbitt a bearing and how to connect a main steam pipe from boiler to engine.

13. Tell why increasing the pressure of a boiler increases the temperature.

14. What size steam and exhaust ports should be used in the engine mentioned in question No. 1.

15. Explain the construction and describe the operation of a hydraulic elevator valve.

16. What would be the percentage of friction in a steam pipe 400 feet long, 2 inches in diameter, gauge pressure 100 pounds, diameter of opening at outlet end 1 inch?

17. Describe an underfeed stoker and its method of operation and construction.

18. What is the temperature of steam at 95 pounds absolute?

19. Describe what in your opinion is the best way to purify boiler feed water.

20. Describe the construction and operation of the steam turbine.

21. Describe the construction of a superheater and tell what effect superheated steam has on a steam engine.

22. Describe the construction of an A. C. and a D. C. motor.

23. How is the resistance of a copper wire in electric work found?

24. Describe the transformer, the rheostat, the exciter and connections on switchboard.

25. What is the difference between an electric motor and dynamo?

There were other questions asked, but these were the principal ones.

Ontario, Canada. J. J. J.

Blow-Off Valves

EDITOR THE PRACTICAL ENGINEER:

It often happens that the simplest, yet most important, matters escape the attention of both designing and operating engineers. I refer to the practice with blow-off valves. To read the papers I would infer that all was well, but when I get around to the plants I find that a great many are not right. In the first place every boiler should have two valves, the first from the boiler being an angle or "Y" valve, depending upon the room at disposal. This valve should have a renewable disc and should always be perfectly tight. The second valve should be a heavy asbestos-packed blow-off cock. The disc valve must be depended upon to prevent leaking. It must always be opened as wide as possible before blowing down, withdrawing the delicate disc entirely out of the path of the rushing water and scale. The blowing down is done with the blow-off cock, as that is its only function. It does not need to be perfectly tight. It is to protect the other, which is tight. Every engineer ought to be required to make a statement in writing every month that he knows that the blow-off valves are not leaking. A man's salary is a small matter compared

to wastes that often take place from this cause. It is invisible and therefore all the more important to have a good system of taking care of it. There is nothing new in the above, but the most important duties of the engineer are not new things. Have a good way of doing things and then a good way of knowing that they have been done. E. S. H.

Louisville, Ky.

Short Rule for Finding Temperatures of Steam.

EDITOR THE PRACTICAL ENGINEER:

Here is a rule which I think will be quite a little help to a good many engineers, which will enable them to determine the sensible temperature of steam in a boiler from 40 to 215 pounds gauge pressure.

Temperature of steam at 40 pounds pressure is 287 degrees. For temperatures between 40 and 60 pounds, add one degree for each pound of steam.

Temperature of steam at 60 pounds is 307 degrees. For temperatures between 60 and 80 pounds add 0.8 for each pound of steam.

Temperature of steam at 80 pounds is 323 degrees. For temperatures between 80 and 100 pounds pressure add 0.7 for each pound above 80 pounds.

Temperature of steam at 100 pounds gauge pressure is 337 degrees. For temperatures between 100 and 120 pounds add 0.6 degrees difference in temperature for each additional pound pressure above 100 pounds.

Temperature of steam at 120 pounds is 349 degrees. For temperatures between 120 and 140 pounds add 0.5 for each pound pressure.

Temperature of steam at 140 pounds is 360 degrees. For temperatures between 140 and 160 add 0.5 for each pound additional pressure above 140 pounds.

Temperature at 160 pounds equals 370 degrees. Between 160 and 185 pounds add 0.4 for each pound pressure.

Temperature at 185 pounds equals 381 degrees. Between 185 and 215 pounds add 0.4 for each pound pressure, the temperature at 215 pounds being 393 degrees.

Fall River, Mass. H. M.

Dimensions for 2500 H. P. Compound Condensing Engine.

EDITOR THE PRACTICAL ENGINEER:

I notice on pages 22 and 23 of the August issue, in reference to the 2500 H. P. compound condensing engine, where R. T., of Germantown, Pa., says that an area of 907.2 sq. in. will make a diameter of 33.09 inches, whereas I find to make that diameter requires 1094.94 sq. in. With his dimensions, only 1195.6 horse-power would be obtained from the cylinder.

As regards the question relative to the cross-compound condensing engine, the following data is required: Diameters of high and low-pressure cylinders, length of stroke, number of revolutions, economical initial, terminal and mean effective pressures of both cylinders and economical points of cut-off.

Assuming a boiler pressure of 175 pounds absolute, and allowing the cut-off to occur in each cylinder at ¼-stroke, which will give 4 expansions in each cylinder, or 16 expansions in both cylinder, the terminal pressure in the high-pressure cylinder is obtained by dividing the initial pressure by the number of expansions in the high-pressure cylinder, or $175 \div 4 = 43.75$ pounds. As the initial pressure in the low-pressure cylinder equals the terminal pressure in high-pressure, in the theoretical engine, the terminal pressure in the low-pressure cylinder will be $43.75 \div 4 = 10.93$ pounds.

The mean effective pressure of the high pressure cylinder is readily found from the formula $P \times (1 + \text{hyp. log. of } R \div R) - p$, in which P = initial pressure, R = ratio of expansion, and p = back pressure. In this problem $R = 4$ and the hyp. log. of $4 = 1.3863$, so that the mean effective pressure of the high-pressure cylinder $= 175\ (1 + 1.3863 \div 4) - 43.75 = 60.65$ pounds. Assuming the engine is condensing to 2 pounds back pressure, the mean effective pressure of the low-pressure cylinder becomes $43.75\ (1 + 1.3863 \div 4) - 2 = 24.10$ pounds.

The power should be so divided that each cylinder will perform one-half the required amount, which, in this case, is 1250 horse-power, and allowing a piston speed of 820 feet per minute, the following factors are available for determining the size of the cylinders.

Piston speed = 820 feet per minute.
M. E. P. of High Press. Cyl. = 60.65 pounds.
M. E. P. of Low Press. Cyl. = 24.10 pounds.
H. P. of each Cyl. = 1250.

Using the well-known horse-power formula for determining the areas of the cylinders, the area of the high-pressure cylinder is found to be 1056.04, and that of the low-pressure cylinder 2667.67 square inches, from which it is found that the diameter of the high-pressure cylinder is 32.49 inches, and the diameter of the low-pressure cylinder 51.55 inches. Assuming the engine to run at 82 revolutions per minute, the stroke becomes 5 feet, so that all the data necessary for the 2500 horse-power compound condensing engine is obtained as follows:

Diam. of High Pressure Cylinder = 32.49 inches.
Diam. of Low Pressure Cylinder = 51.55 inches.
Length of Stroke = 5 feet.
Number of Revolutions = 82.
Terminal Pressure in H. P. Cyl. = 43.75 pounds.
Initial Pressure in L. P. Cyl. = 43.75 pounds.
Terminal Pressure in L. P. Cyl. = 10.93 pounds.
M. E. P. in H. P. Cylinder = 60.65 pounds.
M. E. P. in L. P. Cylinder = 24.10 pounds.
Vacuum = 26 inches.
Boiler Pressure—absolute = 175 pounds.

New Bedford, Mass. B. A. L.

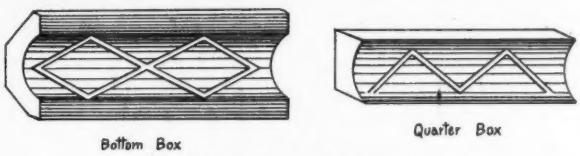
Babbitting a Main Bearing

EDITOR THE PRACTICAL ENGINEER:

Occasionally a main bearing of an engine needs rebabbitting, and while it is not a difficult job, it may, nevertheless, give considerable trouble if one does not know very well how to proceed. Sometimes, if the box is in four quarters, it may be taken to a machine-shop and the work done there, but it often must be poured on the engine by the engineer himself. Sometime ago, a 14"x36" Corliss engine, located where a machine-shop was unknown, needed overhauling, and among other repairs the main bearing needed rebabbitting. This was done as follows: All the old babbitt was chipped out and the bottom box put back in place. The crank-shaft was levelled and supported by a jack. Another jack was placed against

the crank, pressing it tightly against the side of the bearing. The bottom box was then poured, taken out, the edge trimmed of babbitt and then replaced. The quarter-boxes were then placed in position and separated from the bottom box by thin cardboard, in order to prevent the babbitt from adhering to the bottom box. They were then poured, taken out, trimmed and replaced. Wooden liners of the required thickness were put in and the top box poured.

All the boxes were now taken out, oil-grooves cut in them and scraped. The oil-grooves were cut with a half-round or



Main Bearing Boxes

gouge chisel in the shape of the letter "M," as shown in sketch, and the edges were bevelled to a half-inch. This method insures a good distribution of the oil over the bearing. The top box had no oil grooves cut in it, the edges only being bevelled, as this box is not supposed to bear heavily on the shaft. A little tallow candle was thrown into the hole in which the babbitt was to be poured, which is valuable in keeping the metal from blowing up.

Burlington, Ia. G. E.

Pump Problem.

EDITOR THE PRACTICAL ENGINEER:

In your December issue, Mr. Mason offers quite an elaborate formula for finding the pressure per square inch against which the plunger of a pump is working. The data furnished is as follows: Diameter of plunger, 1½"; stroke, 6"; number of strokes per minute, 15; power consumed, 5 horse-power. As all the losses are to be neglected, the following will give a satisfactory answer with a simpler process:

As there are fifteen 6-inch strokes per minute, and as the plunger is 1½" in diameter, a column of water 1½" diameter would be raised $15 \times 6 \div 12 = 7\frac{1}{2}$ feet. Now, as the power expended is $5 \times 33{,}000 = 165{,}000$ foot-pounds per minute, the pressure exerted on the area of the piston would be $165{,}000 \div 7.5 = 22{,}000$ pounds, and as the area of the piston is 1.76715 square inches, the pressure per square inch is $165{,}000 \div 1.76715 = 12{,}499.42$ pounds.

Of course, the friction and other losses were not to be considered and the above method fills the bill and is a much more simple method than that of Mr. Mason's solution.

Pacific Grove, Cal. J. H. C.

Pump Problem.

EDITOR THE PRACTICAL ENGINEER:

Enclosed herewith find solution of Mr. Mason's pump problem, which I think is more direct and simple than his solution, and at the same time is more accurate, as it is not necessary to use the approximate constants, 434 and 27.7, which are perhaps responsible for the different answers.

In this solution it is not necessay to first determine the cubic feet, the corresponding head nor the pounds of water discharged per minute. It is only necessary to remember that the horse-power of a pump, engine or other moving device is equal to (feet per minute × pounds ÷ 33,000).

In the problem, the data given is as follows: Diameter of plunger, 1½", or 1.7671 square inches in area; strokes per minute = 15; length of stroke = 6", or .5 feet; work done equals 5 horse-power. If P = pounds per square inch required to be found, then

$$\frac{.5 \times 15 \times 1.7671 \times P}{33{,}000} = 5, \text{ or,}$$

$$P = \frac{33{,}000}{15 \times 1.7671} = 12{,}453 \text{ lbs. per sq. in.}$$

Fairport Harbor, O. E. S. H.

J. E. M.'S Condenser and Feed Water Heater

EDITOR THE PRACTICAL ENGINEER:

I have read with interest the description of the special combination condenser and feed water heater described and illustrated by J. E. M., on page 23 of the October number.

Supposing that the steam is admitted to the chamber around the feed coil, it is not plain that the arrangement will lower the pressure at the exhaust valve of the engine. It will, of course, give an economy in heating the feed water passing through the coil, but aside from this the arrangement shown has no advantages, and the complications for spraying water into the space at one side of the perforated partition, being of no use, had better be dispensed with. To uphold this statement that the condensing part of the apparatus is no good, it is only necessary to ask how much vacuum could be obtained in a surface condenser, or in any condenser for that matter, when the space in which the vacuum is supposed to be formed has two large openings connecting it with the atmosphere.

Granting that the total area of the openings in the perforated plate is equal to the area of the exhaust opening to the atmosphere, there will still be considerably more than half of the steam exhausted direct to the atmosphere, this being due to the greater distance the steam must travel before reaching the perforated plate, and to the difficulty experienced in dividing a volume of steam up as necessary to be done for it to pass through the plate. No doubt the master mechanic to whom J. E. M. refers has been deceived into believing that there is a vacuum formed on account of the economy had by the receiver-like action of the arrangement shown, as compared with the resistance of the ordinary exhaust pipe. If the connection from the engine to the heater is comparatively short there will be a considerable gain on this account.

In a word, the difficulty with the apparatus, or rather with the mechanic's theory of its action, may be seen in considering the definition of a vacuum, which is nothing more than empty space. If air was a viscous substance, flowing with difficulty, the mechanic's theory might well be supported, but while it flows as freely as at present, it is useless to assume that a vacuum can be formed in any vessel which has free communication with the atmosphere. M. W. A.

Rougemont, N. C.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Remedy for Noisy Valve Gear Wanted.

EDITOR THE PRACTICAL ENGINEER:

The head-end valve-gear on the engine I am running makes a very disagreeable noise. The noise seems to be caused by the latch striking the cut-off cam. I have covered the cam with leather but it does not help any. If anyone can tell me a remedy for the trouble I will be greatly pleased. A. C.

Hornbeak, Tenn.

Use of the Hatchet Planimeter

EDITOR THE PRACTICAL ENGINEER:

In the October number, on page 14, 2nd column, 2nd paragraph, it says, "Locate the point *t* midway between *h* and *k* and measure the distance from *t* to *s*. The distance *t s* then represents the net movement of the hatchet, which means the net movement of the recording point of the planimeter. Now, what I don't understand is this: Why do you locate *t* midway between *h* and *k* to get the net movement of the hatchet? I should think the movement would be from *h* to *s* and from *s* back to *k*. I tried this, making my hatchet planimeter so it would follow a straight line exactly. I tried it on a card and it worked to the opposite side than shown in the diagram. Then when I turned the card around, as explained, going the opposite direction, it worked back to where I started from. I then doubled the distance to the point where it worked out to, and it figured out almost exactly. Will you kindly explain this?

Lisbon, Ohio. F. E. A.

EDITOR THE PRACTICAL ENGINEER:

In the October issue of your excellent paper there appeared an article by R. T. Strohm on the "Hatchet Planimeter." I was sufficiently interested in the article to make one but I do not quite understand the handling of it. Will you please answer the following questions about it: When the card has been arranged on the white paper and placed on the board, the tracing point is placed at the center of gravity *a*, and the hatchet end at *h*. Now when the tracing point travels around the outline of the diagram, is the hatchet to have the same full movement, only 10" lower down, or is the idea to hold that end as near one place as possible, so long as the point does not depart too much from the outline, but when it does, then slide the hatchet end along? How do you handle this?

Lawrence, Mass. P. E. M.

These questions were referred to Mr. R. T. Strohm, who wrote the original article on the "Hatchet Planimeter," and his reply follows:

"In reply to the several inquiries of your readers concerning statements in my article in the October issue of THE PRACTICAL ENGINEER, I offer the following:

"The use of the term 'net movement' of the recording point is perhaps ill-advised, and was employed merely as a means of designating the distance *t s*, and not with any special meaning attached thereto. The movement of the hatchet edge from *h* to *s* and back to *k* is certainly the entire travel of the recording point, and cannot be termed anything else. The distance *t s*, which I called, for convenience only, the net movement of the recording point, is the quantity that must be measured and multiplied by the length of the planimeter, to obtain the area of the diagram.

"Why the point *t* is located midway between *h* and *k*, and why *t s* is then measured, I do not pretend to be able to explain satisfactorily, for the simple reason that I do not know the mathematical process by which the accuracy of this type of planimeter is determined. Like your inquirer, I should be pleased to see a mathematical demonstration of this point. It would be both interesting and instructive.

"However, I can state with certainty that the method outlined will, if followed closely, give accurate results. I have repeatedly tested a planimeter of this type, and in numerous cases the result obtained differed only .01 square inch from the area obtained by the Amsler polar planimeter. This, I think, should allay any doubts as to the accuracy of the instrument when correctly made and properly manipulated.

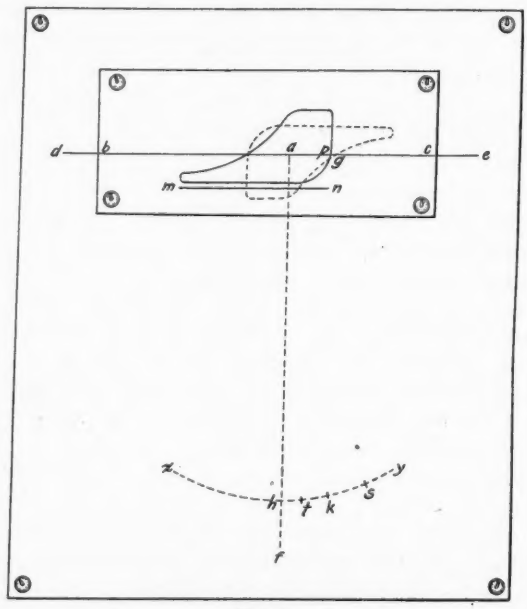


Fig. 2

"In drawing Fig. 2 of the article in question, an error was made. Your correspondent is correct in stating that the various positions of *s* and *k* are not on the right of the line *a f*. They should be on the left of this line, for the shape of diagram shown and the positions indicated. However, this will not necessarily be true for all shapes of diagrams, and it will depend on whether the card is from head-end or crank-end. No matter where the points *s* and *k* may chance to fall, the point *t* should be located midway between *h* and *k*, and the distance *t s* should be measured. If the final position *s* of the

recording end of the planimeter should fall at *h*, the starting-point, then the distance *t s* becomes simply the distance from *h* to *s*.

"In using the hatchet planimeter, the hatchet end should be left free to move, and should not be constrained in any manner whatever. That is, after setting the tracing-point at *a* and the hatchet-edge at *h*, the longer leg of the instrument should be grasped lightly and the point then moved around the diagram, permitting the hatchet-end to move up and down as it will. But the hatchet should *not* be forced to assume any other position than that which it would freely take in following the irregular movement of the tracing point. The path of the hatchet-end is wholly unlike that of the tracing-point. The tracing-point follows the diagram outline, while the hatchet-edge, if its path of motion were marked, would travel in a sort of zigzag line. In other words, the motion of the hatchet must not be interfered with in any way."

R. T. Strohm.

Controlling Boiler Feed Pumps.

Editor The Practical Engineer:

In slowing down a boiler feed pump, is it better to throttle the steam or throttle the water supply? There is quite a difference of opinion in our plant and we would like you to settle this question for us.

Detroit, Mich. M. G. A.

The pump should always be controlled by throttling the steam valve. It is not desirable to control a direct-acting pump by a valve on the suction, because the water cylinder of the pump should always be filled at each stroke. Otherwise when the pump reverses, part of the stroke will be made against little or no resistance, which will cause a serious jar in the pump mechanism.

Cleaning Nickeled Pipes

Editor The Practical Engineer:

How can I remove carbonized cylinder-oil from the exterior of indicator piping without destroying the nickel-plating?

Northampton, Pa. C. S. M.

A solution of two per cent. sulphuric acid and 98 per cent. alcohol is said to be a good nickel-plating cleanser. The solution should be allowed to remain on the pipe only about five seconds when it should be washed off with water and rinsed with alcohol and the pipe rubbed with a polishing-cloth. The yellowest and most tarnished pipes can be brought to their original brilliancy by using this method.

The "S-C" Water Level Regulator.

The value of having a constant water level in a boiler is so well known that various means are adopted so that this desirable end shall be attained. Under ordinary conditions it is impossible for a fireman having other duties to perform to maintain other than an approximate water level so that some mechanical means must be adopted to keep the water at a point where the driest steam and most economical evaporation is attained.

The "S-C" Water Level Regulator, which is guaranteed to maintain a water level within one inch of a fixed line is shown applied to the water column of a boiler in Figure 1. The regulator consists of a generator, which is a minature boiler, and a diaphragm operating a balanced valve in the feed line to the boiler. The generator is shown at A, Figure 2, and the balanced valve is shown in Figure 3.

The generator is a copper shell containing a loop of ⅛-inch pipe, one end of which connects to the water column at the upper gauge cock level by means of pipe C, Figure 2, and the other end connects to the pipe D, which leads to the water column at the lower gauge cock level. This makes a free water column like a water glass, and the generator contains just enough water to cover this loop.

The generator is placed on the column so that line G is on the level where the water is required to stand in the boiler. When the water in the boiler is just above this line, the loop is filled with water and has a temperature below boiling. As

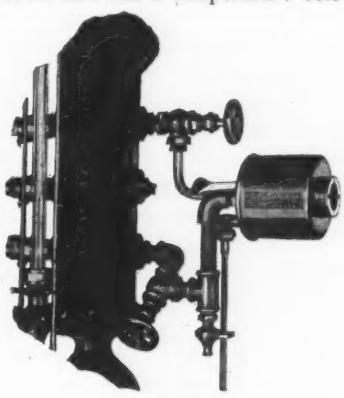


Fig. 1

the water in the boiler drops, it drops correspondingly in C and in the loop, and as soon as steam enters the loop it at once begins to boil the water in A, forming a pressure which drives the water through F, opening the balanced valve in A, Figure 3, allowing the pump to feed the boiler.

As soon as the pump has raised the water in the boiler so it displaces the steam in the loop, the steam in A, Figure 2, condenses, relieving the pressure on the diaphragm, D, which allows the spring in C, Figure 3, to close the valve, retarding the motion of the pump. Before the pump has stopped, the steam again enters the loop in the generator, which allows a steady stroke of the pump and a practically constant water level.

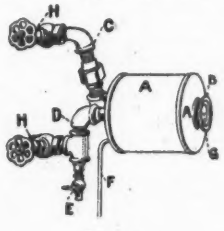


Fig 2

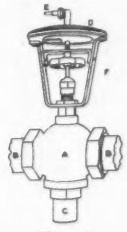


Fig. 3

Water level in the boiler can be changed to any height by changing the nipples in C and D, Figure 2.

All the parts of the water level regulator are made of brass or copper, except the diaphragm, which consists of specially prepared composition rubber. The whole apparatus is furnished ready to attach to the water column and can be put in operation in several hours while the boiler is in use. The "S-C" Regulator Company, corner Perry and High Streets, Fostoria, Ohio, are the manufacturers.

An Interesting Application of Pennsylvania Flexible Metallic Tubing.

The application of the use of flexible metallic tubing is no better shown than in the use to which it was put in the Pratt Street Power House of the United Railways and Electric Company of Baltimore, Md. Owing to insufficient steam capacity, caused by a fire several years ago, and also to the increase in business of the plant, the engineers were confronted last winter with the problem of taking care of the heavy traffic about Christmas-time without being able to increase the boiler capacity of the plant, the new boilers which were being erected not being available in time to meet the increased load.

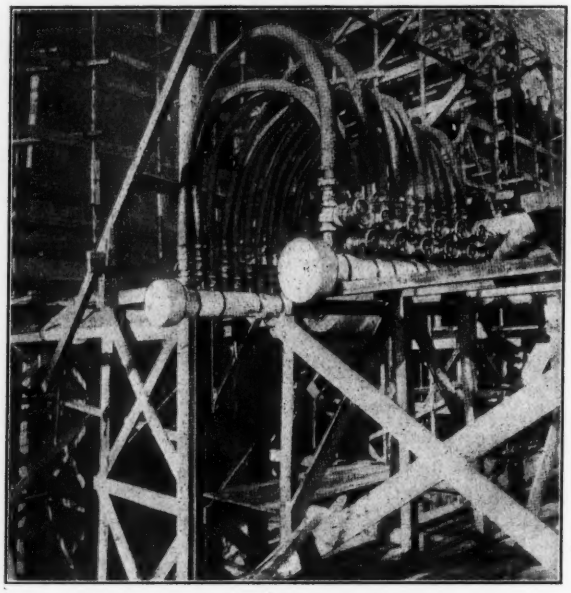
After careful consideration, the company's engineers hit upon the scheme of augmenting the boiler capacity at this station with steam taken from the boilers of a steamboat. Accordingly, the company chartered a large passenger steamer the "Lord Baltimore," engaged during the summer in the regular service between Baltimore and Philadelphia, but which was out of commission at the time and laid up for the winter.

The steamer was brought alongside of the dock adjacent to the power-house and by means of an ingenious arrangement of Pennsylvania Flexible Metallic Tubing, connections were made so that the steam generated in the boilers of the steamboat could be utilized for operating the engines in the railway power-house. The boiler equipment of the steamer consisted of four 250 hourse-power Almy water-tube boilers, giving a total of 1,000 horse-power capacity. The boilers were built to operate at 200 pounds' pressure. No changes were made in the steam equipment on the steamboat, other than to disconnect the boilers from the engine.

To utilize the steam from the boat, a 10-inch tap was taken off from the main 10-inch steam header in the boiler-room of the power station and a 10-inch pipe was extended to the water-edge, where the steamer was moored. The end of the 10-inch pipe was supported at the edge of the pier on trestlework, where it terminated in a 10-inch manifold. On the upper deck of the steamer was a second manifold 8 inches indiameter.

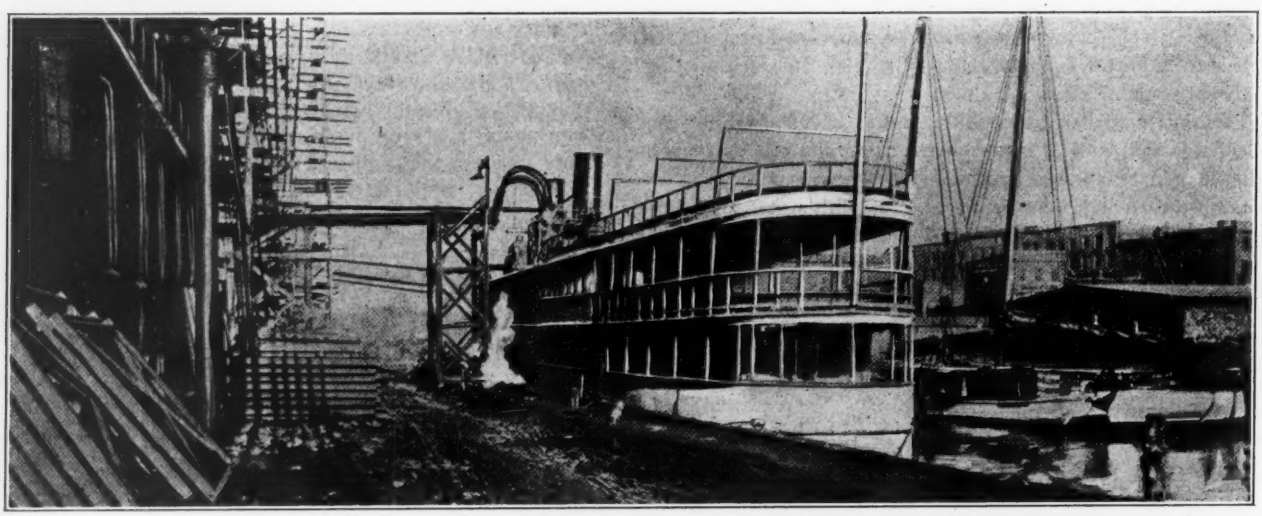
The ingenious arrangement of connecting the two manifolds consisted of a series of 2-inch flexible metallic tubes, which allowed for the rise and fall of the steamer with the tides, the arrangement giving a maximum range of 7 feet. The 8-inch manifold on the steamer was connected by a single 8-inch header to the main steam drum of the ship's boilers.

To give proper control over the steam supply from the boat,



Detail of Flexible Metallic Tubes Connecting Steamboat with Land Pipes to Allow for Rise and Fall of Tides

a 10-inch stop-valve was placed on the 10-inch pipe just inside the boiler-room and to avoid any possibility of bleeding the station boilers, in the event of the steam-pressure in ship's boilers dropping below 200 pounds, a non-return automatic valve was placed in the 10-inch line near its outer end at the water-edge.



Method of Connecting with Flexible Tubes the Boilers of Steamboat to Boilers in Pratt Street Power House, Baltimore, Md.

While designed originally as an emergency measure, the arrangement proved so satisfactory during the intense cold winter, that its use was continued, it being utilized for several hours every day during peak load.

The Pennsylvania Flexible Metallic Tubing, which made this

arrangement possible, is manufactured by the Pennsylvania Flexible Metallic Tubing Company, 1305 Arch Street, Philadelphia.

Martin Anti-Friction Rocking Grate.

In these days of increasing cost of coal and with the universal desire for economy and the reduction of the smoke nuisance in manufacturing plants, most engineers with hand-fired boilers are giving some attention to the matter of a good shaking and rocking grate.

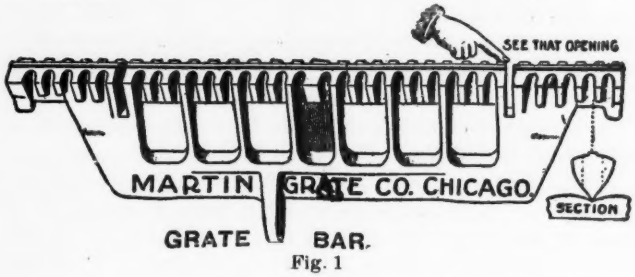


Fig. 1

We are illustrating herewith the Martin Anti-Friction Rocking Grate, a type which seems to differ from most other devices of this kind, and one which the makers claim is very largely in use throughout the country under the boilers of many of the largest steam-making plants where costs are analyzed very closely.

Fig. 1 shows a grate bar in detail, and particular attention is called to the slots at each end, which allow for expansion at the fire-line, and the fact that the heavier part of the bar is five inches below the fire, with a cross-ventilation, which prevents the bar from heating sufficiently to warp. This grate-bar is only 1½ inches wide, including the teeth, and is "fool proof" in the fact that a careless fireman cannot leave any part of it projecting up into the fire to be burned off.

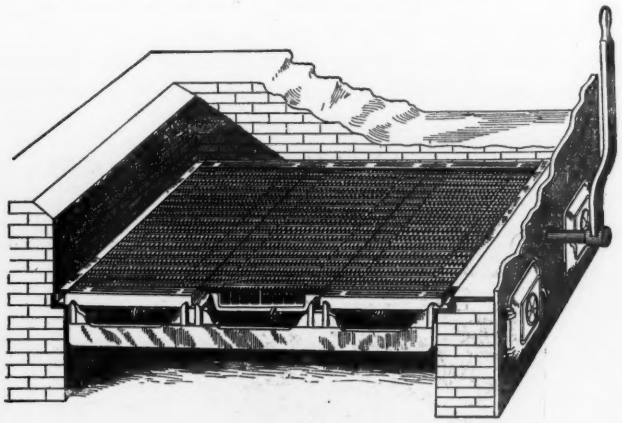


Fig 2

Fig. 2 shows a setting commonly used for horizontal return tubular boilers. The grate-bars run lengthwise of the furnace and the surface of the grate is as smooth as a plain grate. Attention is called by the makers to the manner in which the grate-bars rest on the bearing-bars. The inverted cone-bearing prevents friction and makes it very easy to shake the grate.

One of the most important claims of the manufacturer is that the Martin Grate is especially adapted to burn the cheaper grades of coal.

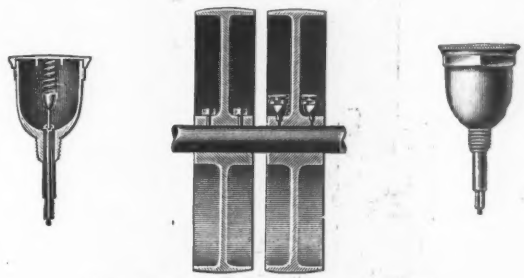
In operation, the grate-bars all work together and in the same direction, and the act of shaking does not increase the openings between the bars. This provision, of course, prevents the waste of fine uncomsumed fuel into the ashpit and also prevents clinkers or coal from dropping between the bars and clogging them. Engineers will be interested in knowing that the Martin Grate is suitable for any kind of boiler, that its installation requires not change whatever in the furnace or ironwork, and that it is one of the heaviest grate-bars on the market.

The Martin Grate is manufactured by the Martin Grate Company, the main office of which is No. 279 Dearborn Street, Chicago.

Lubrication of Loose Pulleys.

Owing to the use of improper lubricants, imperfect alignment, too tight a fit or excessive overloads, the bearings of loose pulleys are often more or less bothersome to the engineer who must look after them.

An important condition, not only with loose pulleys, but other machinery, is proper lubrication, so that the bearings will not become heated or become seized, causing the parts to be strained, twisted or broken.



The Albany Loose Pulley Grease Cup

To successfully accomplish the proper lubrication of loose pulleys, a lubricant should be selected which will not be affected by centrifugal force and which will be ever ready to allow the proper amount to flow as the conditions of the bearing vary. One method of lubricating loose pulleys, is by means of a loose pulley cup, made by the manufacturers of Albany grease. The special feature of this cup is the tube and the interior spindle, the latter being always in contact with the shaft, thereby conducting the variations in temperatures into the body of the grease contained in the grease cup. The consistency of Albany grease, which has a lower melting point than most other greases and which melts at about 170 degrees, is not changed in the cup except in that portion adjacent to the spindle, which liquefies when the temperature rises, and the grease is drawn to the shaft by capillary or molecular attraction, thus lubricating the bushing of the pulley.

When the loose pulley is at rest the grease stops its flow automatically and the bearing will be clean and free, there being no drip and spatter causing annoyance and damage to material and fixtures. The danger of fire, due to a hot bearing and the damage to belts, caused by oil drippings, are thus eliminated. Adam Cook's Sons, 313 West Street, New York, are the manufacturers.

The Otis Improved Heater and Oil Separator.

The improved type of the Otis Feed-water Heater, Oil Separator and Purifier, is shown in the accompanying illustration. The latest improvements which have been made upon it are the settling chamber below the tubes, and the condensation separator and oil extractor.

The Otis Feed Water Heater, Oil Separator and Purifier

The heater is of substantial construction throughout, the body or shell being made of boiler-iron or steel, the top-end of which is riveted to a heavy cast-iron ring, with a projecting rim cast upon its outer surface, to which the tube-sheet and top dividing-plate is attached by a row of bolts. The lower end of the shell is riveted to a heavy cast-iron conical bottom, which is supported by four legs.

The operation of the heater is as follows: The exhaust steam enters the heater at the top and passes down one section of tubes into the enlarged space of the water and oil-catcher at the bottom, where the water and oil are separated. The exhaust steam then flows up through the other section of tubes, thus passing twice through the entire length of the heater. The exhaust steam can then be used for heating purposes, or it can be exhausted into the atmosphere.

The water enters the heater near the bottom and passing upwards in contact with the heated tubes, gradually becomes thoroughly heated and is discharged as near the top as practicable without carrying the scum that is on the surface of the water into the boiler.

The tubes are made of seamless brass, the combined area of which is of sufficient size to allow the water to pass slowly through them. This allows the sediment to be separated and to settle to the bottom of the heater. The top of the lower tube-sheet being at an angle of 45 degrees, will not retain the sediment on its surface, so it gradually collects in the cool settling-chamber below where it can be blown out through the mud blow-off or be cleaned out through the man-hole.

The exhaust steam, after passing through the heater, can be used for heating purposes and the water of condensation can be returned to the boilers, because the oil that is carried over from the cylinder with the exhaust is extracted and passed off through the waste pipe at bottom of heater. The scum which may collect on the surface of the water is carried off by a skimming-pan placed close to the surface and is blown out by opening the valve in scum-pipe.

The reduction of back-pressure is based upon the principle of making the combined area of the tubes greater than the area of the exhaust pipe, thereby tending to create a vacuum as the steam is condensed. Each heater is tested to 175 pounds hydraulic pressure and contains one square foot of heating surface per horse-power. The Stewart Heater Company, 7 Norfolk Avenue, Buffalo, N. Y., are the manufacturers.

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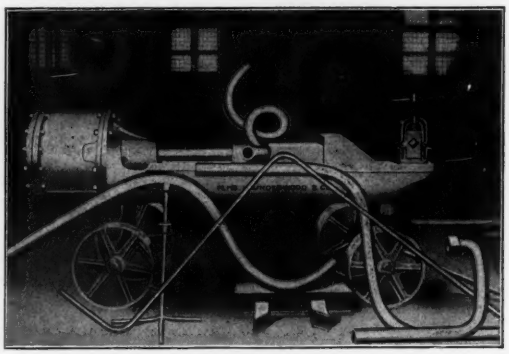
Underwood Pneumatic Pipe Bending Machine.

The accompanying illustration shows a pneumatic pipe-bending machine which will fill a long-felt want of many who have pipe-bending to do, especially those who have been compelled to do it by hand machine, or who have had to use the method of filling and heating. It has been in practical use for a number of months in a large railroad repair shop, one machine doing all the pipe-bending required in equipping locomotives, air-brake and other regular work. When in operation it will make a right-angle bend in a 2-inch pipe in two minutes. Dies for ½" to 2" pipe of standard radius are furnished for locomotive work, and special dies of any required radius or shape are furnished to order. No matter what size of pipe is used, or character of bend that is made, the machine does not flatten or injure the pipe in any way.

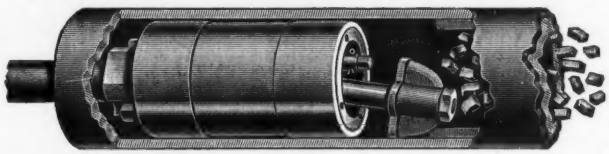


Underwood Pneumatic Pipe Bending Machine

The machine is being manufactured and placed upon the market by the well-known firm of H. B. Underwood & Co., Philadelphia, Pa., who have been making a line of portable tools for many years. This machine is a valuable addition to their already numerous high-grade tools which have become a standard in many of the best shops in the country.

Fighting Boiler Scale.

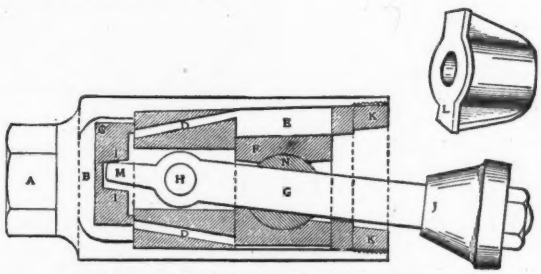
Lieutenant H. C. Dinger, U. S. N., under the caption "Cleaning Marine Boilers," in the October issue of the *International Marine Engineering,* writes most interestingly about the scale problem.



The Dean Tube Cleaner Working in a Water Tube Boiler

Speaking of scale he says:

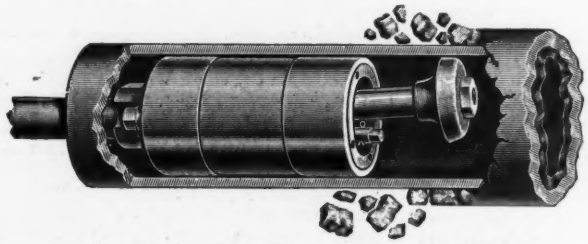
"Scale may not be uniformly deposited, and as scale is a non-conductor, those places where the scale is thick are liable to become overheated. All deposits of scale, oil and dirt, being non-conductors, greatly reduce the efficiency of the heating surface, causing the boiler to have much less steaming capacity and to be wasteful of fuel.



Section of the Dean Boiler Tube Cleaner

"Scale is caused by the various salts contained in sea water when the water is evaporated and converted into steam. It is especially obnoxious in producing leaky joints, especially at the tube ends, and also at joints in the piping."

What he says of sea water is no less true of fresh water, the only difference being that the latter contains different scale-forming properties.



The Dean Boiler Tube Cleaner Working in a Return Tubular Boiler

Lieutenant Dinger says: "In order to thoroughly clean the tubes, mechanical means are usually necessary." He mentions two devices for this purpose, one of them being the Dean Boiler Tube Cleaner.

Speaking of this tool he says: "The Dean Boiler Tube Cleaner is a handy mechanical device used for cleaning tubes of water-tube boilers. It is made by William B. Pierce Company, 329 Washington Street, Buffalo, N. Y. This cleaner is operated by compressed air or steam. It is especially adaptable to hard scale, and is very largely used in power-plants on shore.

"Its operation is as follows: The nozzle A, attached to a hose or gas pipe of suitable length, carries compressed air or dry steam into the valve-chamber *B,* and thence goes alternately through the ports DD into the piston chamber E. At a pressure from 40 to 80 pounds, the piston F moves the hammer-handle *G* to and fro, imparting a vibrating motion to the hammer *J.* The handle of the hammer, being pivoted at *H,* works the valve C so as to cover the ports in alternation. The whole tool being inserted in the boiler tube, the hammer-head vibrates with tremendous rapidity of from 3,000 to 4,000 times a minute; and as it vibrates, striking the tubes with a succession of very light but very frequent blows, it jars the scale loose. For water-tube boilers, a hammer-head with cutting edges and guards is used. This cracks the scale from the tubes, breaks it up, and a gust of steam or air drives out the loosened particles. The blow struck is a very light and rapid one, and does not mar the metal of the tube.

"Scale in shell boilers may also be removed by special tube-cleaning machines, such as the Dean Boiler Tube Cleaner, the operation of which has already been described. This cleaner will throughly remove the scale on the tubes of shell boilers, many parts of which are inaccessible, to other means of cleaning. The cleaner will jar the scale loose, and also the corroded or incrustated metal of the tubes. It will thus show up any bad places, so that they may be remedied before a rupture takes place. The action of the hammer on the tube jars loose both the scale on the water side and also any hard soot or scale on the fire side. The escaping steam or air blows the soot and dust out, thus thoroughly cleaning both water and fire side of the boiler."

Another Reason For a License Law

EDITOR THE PRACTICAL ENGINEER:

In reference to S. J. K.'s letter, "Is it cheaper to buy new machinery or employ good engineers?" I must say that I saw a similar case in a plant near Louisville, where they had a boiler which was used only for pumping purposes in the summer, and to prevent it from freezing and bursting during the winter they emptied the boiler. After they fired the boiler the next spring they opened a pipe leading from the tank to the boiler, thus filling it to the required height. The proper method, of course, is to have the boiler filled to the correct height before starting the fire, but the engineer there built a hot fire before putting water in the boiler. The boiler was red-hot before the water reached it, and when the water poured into the boiler it exploded. The boiler was of the upright single-flue type, and the explosion tore the flue out and hurled it 50 feet in the air, and the scale that was in the boiler was blown in all directions. A competent engineer should have been employed and the accident would not have happened.

Louisville, Ky. G. A. J.

During a recent test made on a 10,000 horse-power Parsons turbine at the Waterside station of the New York Edison Company, the steam consumption of the turbine was found to be about 14.9 pounds per kilowatt hour. Figured in fuel consumption, this is equivalent to one and one-half pounds of coal per kilowatt hour.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

Their New Loose Pulley Lubricator Grease Cup is described in a pamphlet issued by Adam Cooks Sons, the manufacturers of Albany Grease, 313 West street, New York City.

Empire State Engineering Co. have moved their main office, in New York City, to the new Singer Building.

A circular fully describing the McKnight combination open-feed water heater, purifier, muffler, oil separator, settling chamber, return tank and filter, will be mailed to any engineer writing to Walter J. McKnight, 179 Washington street, Buffalo, New York.

Richard Thompson & Co., 126 Liberty street, New York City, have taken the agency for the Anderson Improved Steam Trap Co.

The "Rapid Turbine Cleaner," for removing scale from water tube boilers, is described in a booklet issued by the manufacturers, Thomas Andrews Mfg. Co., Rockaway, N. J.

If you want to get something more than a mild shock concerning the ravages of boiler scale and some conditions that have been revealed by the Dean Boiler Tube Cleaner, write to the Wm. B. Pierce Co., 329 Washington street, Buffalo, N. Y., for their booklet entitled "Boiler Room Economy."

"Steam Turbines" is the title of the latest catalogue issued by the B. F. Sturtevant Co., Hyde Park, Mass., and illustrates the new turbine which is being built by that company. The turbine is of the impulse type, and owing to its simplicity, durability and absence of governor belts, it is particularly adapted to large fan systems of heating and ventilation. The construction and operation is interestingly described in this catalogue, which will be sent to any reader upon request.

Announcement is made by the *Southern Trade Press*, Atlanta, Ga., that their new book, "How to Build and Operate an Ice Plant," is now on press, and will soon be ready for distribution. It contains 140 pages of practical instruction about the proper method of operating and erecting ice plants, which should prove useful to every engineer, whether he is a refrigerating engineer or not. This book will be sent free to everyone who subscribes for the monthly refrigerating Journal, *Ice*, the subscription price of which is $1.00 per year.

Metal Hose is rapidly coming into favor with engineers for high pressure steam service, such as blowing boilers, etc. An article on another page of this issue shows how a larger power plant, the boilers of which had been disabled, was run from the boilers of a steamboat lying in the river nearby, the steam passing from the boilers of the boat to the engine of the power plant through metal hose, supplied by the Pennsylvania Flexible Metallic Tubing Co., 1305 Arch street, Philadelphia, Pa. A circular describing this hose and giving prices, will be mailed to any one interested.

A clever little catalogue showing a dozen or more cuts of power-pumps for boiler feed service and other purposes, giving sizes, capacities, prices and other valuable information, is issued by the Stewart Heater Co., 7 Norfolk avenue, Buffalo, N. Y.

The Traylor Engineering Co., 2 Rector street, New York City, have issued a catalogue showing their complete line of mining and metallurgical machinery, which will doubtless be of interest to those of our readers who are engaged in mining operations.

Many of our readers may not be familiar with Martin Rocking and Shaking Grates, but if one-half of the good things that 100 or more users have said about them in letters to the company are true, it is a good time to get busy and learn something about the Martin Grate. This grate is shown in detail, and also a great many reliable-looking testimonial letters, in a catalogue issued by the Martin Grate Co., 279 Dearborn street, Chicago, Illinois.

The more an engineer knows about the advantages of a steam engine indicator, the more certain he is to eventually get one, because, without an indicator engineering is more or less like sailing on the high seas without a compass; you always know that you are somewhere, but it is largely a case of guess just where you are at. The indicator catalogue, issued by Jas. L. Robertson and Sons, 40 Warren street, New York City, shows every part of the indicator in detail and explains its purpose. Every engineer who is interested in indicators and has not already received one of these catalogues, should write for one.

In the Squires Steam Trap the only working part in the body of the trap is the cast iron bucket, hinged on cone-bearings, which cannot corrode or stick, and which is so arranged that the valve has a lift just in proportion to the area, giving a positive and intermitent discharge. The arrangement is such that the valve is always water-sealed, preventing the escape of any steam, all of which, together with full description of the trap, is shown in a very handsome catalogue issued by the Strong, Carlisle and Hammond Co., 346 Frankfort street, Cleveland, Ohio.

"Four to six horse-power for one cent an hour" is the remarkable claim made in the catalogue of the Industrial Power Co., of 419 Iron Block, Milwaukee, Wis. This is accomplished through the use of Producer Gas, generated with the Atkinson Producer, which is shown and fully described in the catalogue; together with a summary of the general advantages of producer gas, and a table computing the cost of producer gas power with coal, at different prices. Readers interested in producer gas can get a copy of this catalogue by writing for it.

The Northern Specialty Company, Utica, N. Y., manufacturers of the Northern Self-Closing Safety Water Gauges, have established a branch office in Pittsburg, Pa. This office is in charge of Mr. J. V. Templin, 525 Third avenue, Pittsburg, Pa., who is also connected with the Engineers' Supply Company, of that city.

The Morehead Return Steam Trap returns the condensation to the boiler. It is especially adapted for laundries, hot-houses and other places where the Morehead trap is intended to do the entire work of the plant, instead of many smaller traps. The manufacturers of this trap have issued a fine large catalogue, with illustrations showing the complete operation of the trap. For a copy, address Morehead Mfg. Co., Detroit, Mich.

Circuit Breakers and Horizontal Edgewise Switchboard Instruments are instructively discussed in the two latest Bulletins issued by The General Electric Co., Schnectady, N. Y.

A free sample bar of Stephenson Bar Belt Dressing will be mailed to any engineer who wishes to give it a trial. Red label for leather, green label for rubber.

The December issue of *Graphite* is particularly interesting, and besides a number of good articles, it contains ten pages of illustrations and descriptions of the recent Street Railway Convention, at Atlantic City, N. J. The Dixon Graphite Exhibit at this convention is described, together with a number of half-tone illustrations of the famous Atlantic City hotels, Boardwalk, piers and sand figures, made to represent Dixon's products. Any of the readers of this paper can secure a copy of the publication by writing to the Joseph Dixon Crucible Co., Jersey City, N. J.

The Monarch Boiler Arch, an advertisement of which will be found on another page of this issue, is fully described in a booklet issued by the Mayville Specialty Mfg. Co., Mayville, Wis. It's worth investigating.

FOR SALE.—One 16 x 26 x 42 Allis Corliss, Tandem Compound engine, first-class condition. Morehead Mfg. Co., Detroit, Mich.

POSITIONS VACANT.—Territorial agents, on contract at liberal commission, to demonstrate in boiler plants a patented machine of recognized worth, selling at moderate price. For further particulars, apply, with references, to Thomas Andrews Mnfg. Co., Rockaway, N. J.

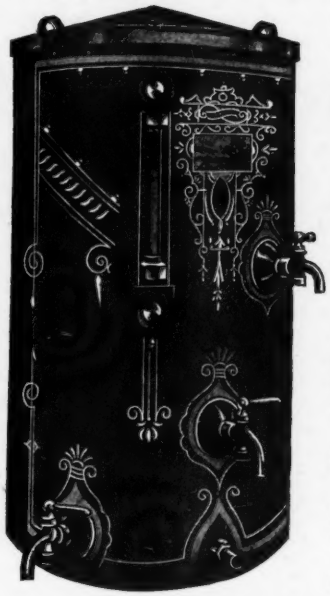
Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory, Address
FRANCE PACKING Co., Tacony, Phila., Pa.

WANTED.—Engineers and Mechanics to make big money selling Incomparable O. K. Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. *O. K. Hand Soap Co.*, 225 Congress Street, Boston, Mass.

PATENTS WATSON E. COLEMAN
Patent Attorney, Washington, D. C.
Advice and books free. Highest references. Best services.

PATENTS
C. L. PARKER
Late Examiner, U. S. Patent Office.
Attorney-at-Law and Solicitor of Patents.
Patents secured promptly and with special regard to the legal protection of the invention.
Handbook for inventors sent upon request.
186 Dietz Bldg. WASHINGTON, D. C.

A Little Oil And A Great Deal Of Lubrication



At a cost of but a few cents a year you can save from 50 to 75 per cent. on oil by use of this Cross Oil Filter.

It is guaranteed against defects and represents all the best features of construction.

Ask for the new 80-page catalog.

The Standard Oil Co. have 88 Cross Filters in use in their own pumping stations.

The Burt Manufacturing Co.

204 Main St., Akron, O., U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

See The Glass Top And Sliding Sleeve Damper

NOTICE—Sliding Sleeve pamper can be furnished with metal top if desired. (Patented).

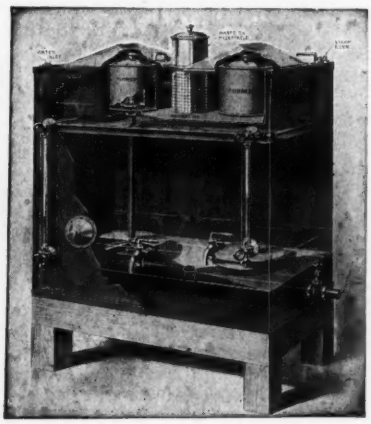
Both light and ventilation, with perfect protection against the elements. Made of extra heavy galvanized iron—no paint to cover defects—if there were any you could easily see them.

The Nordberg Mfg. Co., Milwaukee, recently ordered 48-30 and 48 in. Burts for use on their new foundry—one of the finest in U. S. A. The Jones & Lamson Machine Tool Co., Springfield, Vt., 80-20 in.

We have an 80-page Catalog. Do you want one?

The Burt Manufacturing Co.

204 Main St., Akron, O., U. S. A.



The Burt Unit Oil Filters

So constructed that they can be operated singly or in batteries as large as may become necessary.

They remove all dirt and grit from oil, and save 50 to 90 per cent. Each unit will deliver, clean and pure, 200 to 250 gallons every 24 hours.

The Philadelphia Rapid Transit Co. uses 26 (fifth order) Units. Calumet & Hecla Copper Co., 7 (repeat orders).

Have you our new 80-page Catalog?

The Burt Manufacturing Co.

204 Main St., Akron, O., U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

The Burt Exhaust Heads

protects roofs and walls by separating every bit of condensation water and oil from your exhaust steam.

The Baldwin Locomotive Works uses 53 Burt Exhaust Heads. The U. S. Steel Corporation have 96.

How about our 80-page Catalog? Do you want one?

The Burt Manufacturing Co.

204 Main St., Akron, O., U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

Something that every engineer should send for at once is a copy of the new catalog of the American Steam Gauge and Valve Mfgr. Co., Boston, Mass. This catalogue contains many special illustrations and complete description of the entire line of Gauges, Valves, Indicators and other instruments for governing, indicating, measuring, recording and controlling steam, water, air, gas, oil, ammonia and all other pressures. Mention THE PRACTICAL ENGINEER if you want a copy.

The Philadelphia Grease Cup Co., with main offices in the Bourse, Philadelphia, have been receiving many large orders for their Philadelphia Grease Cups of all sizes. As this cup becomes better known, the demand for it is rapidly increasing. The special feature about the Philadelphia Grease Cup is that it is automatic in its application of the grease to the bearings without the use of spring compression, being so constructed that nature supplies the feeding force in the form of compressed air. A booklet describing this cup in detail will be sent to any engineer upon request.

The Pennsylvania Steel Pulley Company has been organized to continue the business of the Latshaw Pressed Steel & Pulley Company, of Pittsburg, Pa.

The high duty, outside packed plunger pumps, built by the Hooke Steam Pump Co., 218 Granite Block, St. Louis, Mo., have some distinctive features that are well-worth considering when purchasing a pump for high duty work, either as a boiler feeder, in mine work, or elsewhere. Not the least of these advantages are the arrangement for getting at the water valves by means of openings at the side, and the provision for cleaning out under the suction valves.

Do you want a Lunch Box? Turn to the advertisement of the Keystone Lubricating Co. and see what they are offering to give away "free, all express charges prepaid," this month.

During the past few years the Ohio Blower Co., Cleveland, Ohio, has been progressively introducing the Helico-Centrifugal type of oil and steam separator. In this appliance the steam is given a whirling motion, which positively separates the oil and water from the steam through the action of centrifugal force. No obstruction is presented to direct flow. Among recent sales of various types, the following are reported: Steam separators for the Phillip-Carey Mfg. Co., Lockland, O.; The Carnegie Steel Co., Duquesne Works, Pittsburg, Pa.; The General Electrical Co., Fort Wayne Works, Ind., and the Louisville Lighting Works, Louisville, Ky. Also on separators for the Carnegie Natural Gas Co., Pittsburg, Pa.; Standard Welding Co., Cleveland, Ohio, and the General Electric Co., Fort Wayne Works, Ind.

The Standard Engineering Co., 83 Isabella street, Toronto. Canada, are the Canadian Licensee Manufacturers of the Gould Safety Feed Water Regulator, owned by the Safety Equipment Co., of Chicago, Ill.

Philadelphia Gear Works have moved into their large new plant at 1120-22 Vine street, Philadelphia, where, with greatly increased facilities, they are prepared, at least for a time, to take care of their rapidly growing trade. They have issued a mighty good catalogue devoted to gears and gear cutting of every description, a copy of which they will send you if you are interested in gears.

The American District Steam Co., Lockport, N. Y., install steam-heating plants, often on a very large scale, in consequence of which they are necessarily large users of steam traps, and very discriminating, for if the trap fails, the whole system will be unsatisfactory. Now they have designed a special trap of their own, which is said to be giving such perfect satisfaction that they are manufacturing them in large quantities and placing them on the market. Full description and prices may be had from the company.

The story of Marco Diagonal-Wedge Packing is interestingly told on page 79 of this issue. Few advertisements are so thorough, and yet so brief. By writing for a sample piece of the packing and comparing it with the illustrations shown in the advertisement, the strong points brought out will be understood even better.

The Harrison Safety Boiler Works, 3144 North Seventeenth street, Philadelphia, is sending out a quite unusual mail folder on "The Utilization of Exhaust Steam in Wood Working Establishments." With the exception of what is said about the use of exhaust steam in dry kilns and for steaming lumber, the points brought out apply to most steam plants, covering the use of the Cochrane Open Feed Water Heaters and the Hot Process System of Water Purification for keeping scale out of boilers, increasing the capacity of the boilers, and saving coal and boiler feed water. The folder shows an interesting lay-out for engine, heater, drying and heating coils and connections.

Chas. T. Luce Co., No. 160 Congress street Boston, Mass., have secured the New England agency for Sterling Force Feed Lubricators.

Cling-Surface Mfg. Co., 1046 Niagara street, Buffalo, N. Y., have issued a new publication entitled "The Treatment of Belts and Ropes for Service and Profit." This is primarily a book for cling-surface users, its chief purpose being to show the folly of running belts tight instead of running them slack, with reduction of friction load and consequently better economy. This, it is shown, can be done through the use of Cling-Surface Belt Dressing. The book has been carefully illustrated and offers much of both interest and value to every man in charge of any kind of belted machinery. A copy of this book will be mailed, without charge, to anyone sufficiently interested in the subject of belts to request one of the Cling-Surface Co.

The Scully Steel & Iron Co., Halsted and Fulton streets, Chicago, offer to send a Perfection Flue Cleaner to any steam user for thirty days' free trial, guaranteeing absolute satisfaction or no pay. These cleaners are made in all sizes up to six inches and are said to be very efficient. This special offer gives a good opportunity to try them out without risk.

T. T. Burchfield Co., special agents for engines, boilers and other power plant equipment, have moved to larger quarters at 54 N. Sixth street, Philadelphia, Pa.

A well illustrated pamphlet describing the Heath Reciprocating Grate, showing all parts in detail, is issued by the Heath Grate Bar Co., No. 10 Oliver street, Boston, Mass. A special feature of this grate is that the entire fuel surface is corrugated, thus allowing for expansion and contraction without warping. Another feature is that all bars and fingers are grooved on the surface, which serves the double purpose of raking the bottom of the fire and of collecting fine ashes, preventing clinkers from burning to the iron. A copy will be sent to anyone upon request.

The Philadelphia office of the Strong-Carlisle & Hammond Co., manufacturers of the Squire's Steam Specialties, has been moved to No. 54 N. Sixth street, where they now have large storage rooms, and are equipped to fill orders for their Squire's Traps, Squire's Feed Water Regulators, Squire's Pump Governors or other specialties quickly. Mr. Chas. H. Camp is manager of the Philadelphia office.

In order to introduce their All Metal Flexible Ring Packing quickly, the Elastic Metallic Packing Co., 407 Cherry street, Philadelphia, Pa., are offering to send this month a sample ring of their packing free, in order that engineers can see what it is before ordering.

A new calendar for 1908 has been issued by the Liberty Mfg. Co., 6409 Susquehanna street, Pittsburg, Pa. One of these calendars will be mailed to any reader upon request.

A circular describing the S. C. Boiler Feed Regulator and Pump Governor is issued by the S. C. Regulator Co., Fostoria, Ohio, a copy of which may be had upon request.

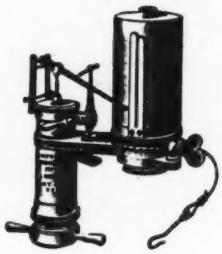
Almost every engineer is interested in Packing Tools. The Mound Tool & Scraper Co., St. Louis, Mo., manufacture a large and complete line of these tools. They issue a booklet entitled "Engineers' Chums," which illustrates and describes the tools in detail. They will send you a copy if you write them.

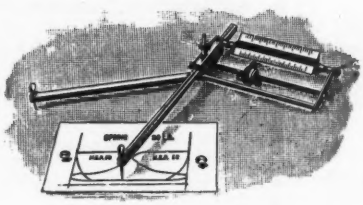
Green, Tweed & Co., 109 Duane Street, New York, will send a sample spool of Palmetto Packing free for trial. See their offer on front cover of this issue.

The Trill Indicator Co., of Corry, Pa., are distributing an excellent catalog describing their indicators, reducing wheels and planimeters. It also contains much useful and handy information about the taking and reading of indicator cards. It shows in detail how to tap the cylinder, make pipe connections, place the indicator, connect it with the crosshead, adjust the tension, etc. The indicator diagram for a single cylinder engine is carefully analyzed and rules given for finding the horse power. Characteristic diagrams from engines of various types, including faulty diagrams are analyzed and suggestion made for their correction. This book will be sent free to every engineer who desires a copy.

The Philip Carey Co., Lockland, Cincinatti, Ohio, have issued an exceptionally handsome catalogue illustrating and describing their complete line of Pipe Coverings and Insulating Materials. This catalogue contains 70 pages, 6 x 9 inches. It is generously edited and the cuts are exceptionally good. It also con-

Jas. L. Robertson & Sons





40 Warren Street,
NEW YORK

offer to the thinking engineer on easy terms of payment the

ROBERTSON-THOMPSON INDICATOR

whose principle and construction are perfect and whose accuracy and durability remarkable. All moving parts are extremely light, simple and strong in construction and handsome in design and for convenience of handling this indicator has no equal.

THE VICTOR REDUCING WHEEL

reduces the stroke to card size avoiding all lost motion and insuring absolute correctness of the indicator diagram. It has no gears; cord wheel revolves on a polished spindle—not on a threaded shaft and the patent spring tension device puts the VICTOR in a class by itself. The cost is moderate.

THE WILLIS PLANIMETER,

which reads M. E. P. direct from card, gives areas of regular or irregular circles or diagrams in square inches, feet and yards without any computation whatever. It is a time-saving addition to the indicating outfit at an easy price.

Easy prices and Terms
Make Easy Buying.

tains much information of genuine value to power plant men. A copy will be mailed free to any reader of THE PRACTICAL ENGINEER, writing the company to the above address.

Some remarkable efficient and overload tests were recently made on the Rust Water Tube Boiler by William Kent, the noted consulting engineer. These tests showed that the Rust boiler is capable of working at 200 per cent. overload and give an efficiency of 75 per cent. The Rust Water-Tube Boiler is one of the newer types of boilers which have been placed upon the market during the past six years and everyone interested in water-tube boilers should have a catalogue which describes these boilers and the tests made upon them. Address Rust Boiler Co., Sixth avenue and Wood street, Pittsburg, Pa.

Gravity Sight-Feed Gang Oilers are shown in a circular issued by the Sight-Feed Oil Pump Co., 161 Holton street, Milwaukee, Wis. These oilers are suitable for use in connection with any machine or engine where oil is fed by gravity or pressure from a supply tank or oil pump, and it is desired to oil a number of bearings from one central position of control. A copy of the circular, which gives prices and full particulars, may be had upon request.

The Massachusetts Fan Co., Watertown, Mass., has just issued an additional section of its Perpetual Catalogue. This section, which comprises 16 pages, and is entitled "Vertical and Horizontal Engines for Fan Driving," includes illustrations, descriptions, dimensions and horse-power tables. The entire catalogue is thus brought up to a total of 116 pages of valuable matter relating to blowers and exhausters, heating, ventilating, drying and mechanical draft apparatus, etc.

Lazier Vertical Gas Engines are comprehensively described and generously illustrated in a richly made, and rather novel, catalogue, which has just reached us. In addition to the detailed descriptive matter and a comparison of actual operating costs, with various forms of power, there are several very interesting blue print pages, showing every detail of construction, and on the reverse side of each blue print is given full explanation of each part. A copy of this splendid catalogue will be sent gratis to any reader who is interested in gas engines by the Lazier Gas Engine Co., 199 Main street, Buffalo, N. Y.

A friction clutch, designed for the heaviest work, with particular regard for simplicity, durability and ease of adjustment, is described in Allis-Chalmers Co's. Bulletin No. 4001, entitled "The Reliance Friction Clutch." All the usual objections have been overcome. Ordinarily, for example, the pulley hub of a Friction Clutch is cut down to economize space on the shaft, and the bearing surface supplied will not properly carry the strain of a tight belt. The strain of the Reliance Friction Clutch, on the contrary, has a very even distribution, it being made with either three or six arms, arranged in sets of three. Each of the sets is connected with an equalizing ring by toggles, and this ring is free to move sideways, so as to equalize the strain on the three arms. The pressure, also, instead of being regulated with springs, can be set according to the load the clutch has to carry.

Armstrong Stocks and Dies have long been favorites with engineers. Indeed, there are few engine rooms in which cannot be found some of the Armstrong Tools, and no engineer should be without stocks and dies for an hour anyway. They save their cost times over every year on the regular work that is necessary around the steam plant, and are indispensable in cases of emergency. A catalogue, fully describing the Armstrong Tools, with special attention to the Armstrong Stocks and Dies, will be mailed to any engineer writing the Armstrong Mfg. Co., Bridgeport, Conn.

The new storage battery catalogue entitled "Westinghouse Storage Battery for Portable Use," has just been issued. While The Westinghouse Machine Company, Pittsburg, Pa., has been in the storage battery business for several years, all the literature issued up to the present time has been devoted to stationary storage batteries. This is their initial publication, devoted exclusively to storage batteries for portable use, and will be sent to any engineer upon request.

NEW POWER PLANTS AND IMPROVEMENTS

The new power plant of the Byrne and Saule Company, Dubuque, Ia., is nearly completed.

The Gloucester County Electric Company will build a new one-story power house at Pitman, N. J., at a cost of $6000.

The Oskaloosa Traction Company and Power Co. have recently made extensive improvements to their power plant at Oskaloosa, La.

The Ballbach Smelting and Refining Co., Newark, N. J., is preparing to erect a one-story brick power house, 50 x 85 feet, at their Newark Bay plant.

The Cuyahoga Light Co., of Cleveland, Ohio, announce their intention of erecting four power plants in the down-town section of that city. John C. Keys is president.

The Glastonbury Power Company, of Glastonbury, Conn., have awarded the contract for an entire new power plant to the Ley Construction Company, of Springfield, Mass. The entire plant will cost about $200,000.

Bids are being received by Architects Kirchoff and Ross, of Milwaukee, Wis., for the erection of the proposed electric power house for the Schlitz Brewing Company, also of Milwaukee. Estimated cost, $75,000.

The Atchison, Topeka, and Santa Fe Railroad is reported as asking for bids for the construction of a power house and electric plant at the yards at Bakersfield, Cal.

The City Council of Puyallup, Wash., is contemplating building a municipal lighting plant, and has engaged Fuller & Manley, engineers, of Tacoma, Wash., to submit plans and estimated cost for installing same.

The National Malleable Casting Co. will erect an addition to its power plant at Toledo, Ohio, and has awarded the contract for the building and equipment to F. C. Werk, electrical engineer, of Cleveland, O.

The Trustees of the Ohio Soldiers' and Sailors' Orphans' Home, in Xema, Ohio, have submitted a request to the Governor of the State for an appropriation of $100,000, to install a complete new power plant and sewage system.

Plans and specifications for the new power plant of the Americus Railway and Light Co., Americus, Ga., have been completed, and building operations will start in January. It is expected that the plant will be in operation by May next.

The new power plant of the Bristol Mfg. Co., Bristol, Conn., is finished and has been placed in operation. An auxiliary water power plant is now being constructed by the company and will be put in operation as soon as it is completed.

The Michoacan Power Company, of Mexico City, Mexico, which is one of the subsidary interests of the Guanajuato Power and Electric Company, with offices at 25 Broad street, New York, is planning to build two large power plants on the Angulo River, Mexico.

Jacob Schlosser, of Chicago, President of the Umatilla Mining Company, and his associates, have located a power site on the south fork of the Clearwater River, near the mouth of Ten-Mile Creek, Spokane, Wash. A new power plant, costing $140,000, will be installed.

The Paul Smith Electric Co. is building a new power plant at Union Falls, near Troy, N. Y., which, when completed, will furnish electricity for Plattsburgh and Paul Smith's railway system. Later, the power will be extended to Saranac Lake and Lake Placid. Estimated cost, $500,000.

The Whatcom County Railway and Light Co., of Bellingham, Wash., is building a substation at South Bellingham. The object of the new sub-station is to generate more power for the electric railway in South Bellingham, and to supply power for the operation of a new flour mill now building.

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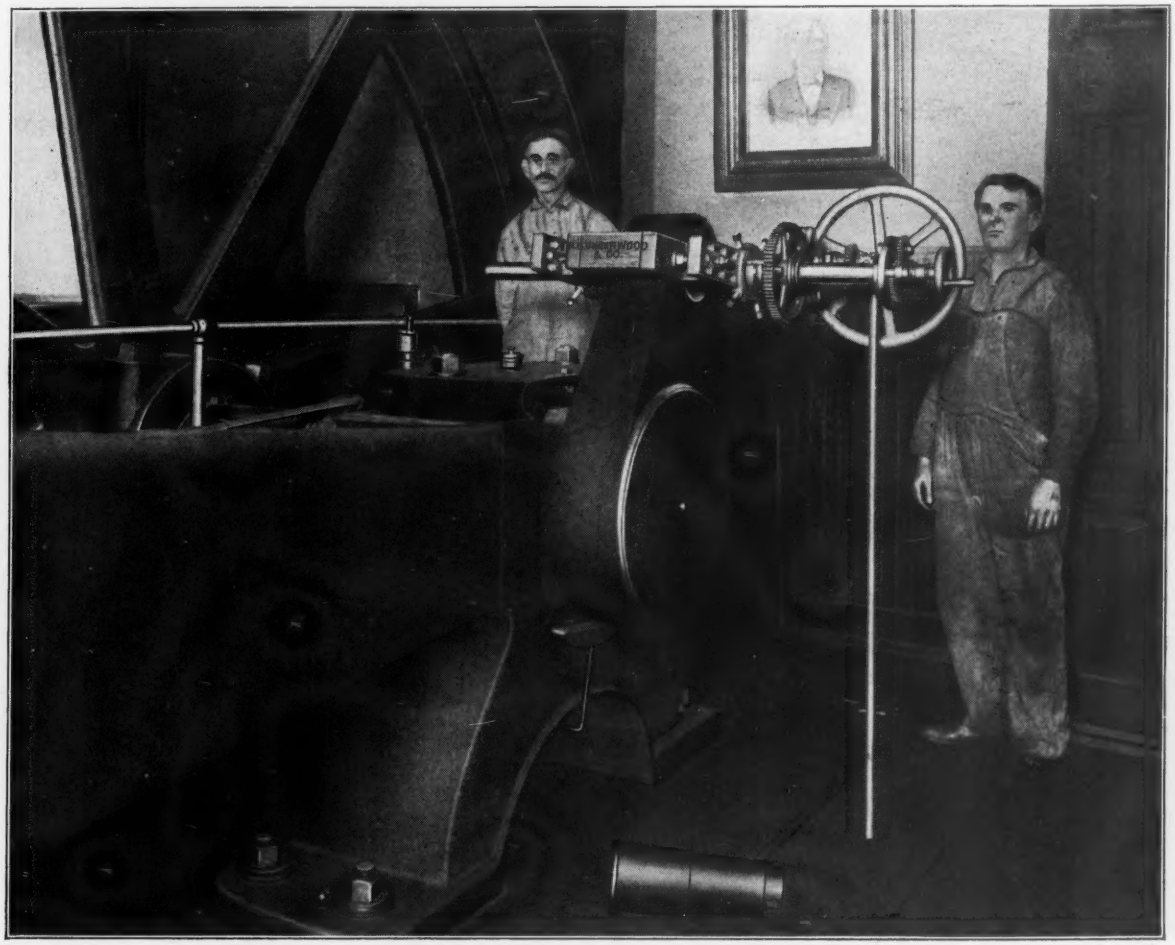

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It is proposed to build in Wichita, Kansas, a heat, power, light and space plant for the purpose of encouraging and aiding small manufacturers. The new company will be known as the Wichita Heat, Light, Power and Space Company, and it is estimated the machinery and plant will cost one-quarter of a million dollars.

Contracts have been let by the Kentucky Electric Company, of Louisville, Ky., to the General Electric Company, of Schenectady, N. Y., for three turbine engines for the new power plant of the company. Plans for the new plant are being prepared by the chief engineer of the company, of which Donald McDonald is President.

A new power company has just been organized in Kalamazoo, Mich., by C. O. Smedley, of the law firm of Smedley & Couvin, H. H. Freeland and F. W. Armstrong, all of Kalamazoo. The object of the new company, which will be known as the Kalamazoo Power Company, will be the supplying of heat and power for business establishments of that city.

The United Railways Co. have awarded the contract for the erection of a five-story building inside their Pratt street power house, Baltimore, Md., to the Noel Construction Company, of the same place. The new structure will be 28 x 84 feet of reinforced concrete, and will be used for a cable vault, switch rooms, controlling gallery and offices. L. B. Stillwell is architect and engineer.

The Department of the Interior is receiving bids for the equipment for the heating, lighting and power plant for the United States Capitol and Congressional buildings. Bids will be received for boiler feed pumps, barometric condensers, centrifugal pumps, motors, cranes and chimneys before January 15, 1908. Address Elliott Woods, Superintendent U. S. Capitol Building and Grounds, Washington, D. C.

Plans are being consummated for a large power plant on the Quiotepec River, in the vicinity of Tomellin, Mexico, where it is intended to generate electric power for the operating of part of the Mexican Southern Railway; also for running electric traction and lighting systems in the city of Oaxaca, and for supplying current for different purposes in some half-dozen other towns within a radius of 100 miles of the power plant. The necessary concessions have already been granted by the Mexican authorities to Edward J. Cummings, of Guanajuato, who has charge of the project.

RECENT BOILER EXPLOSIONS AND POWER PLANT ACCIDENTS

The power house in the yards of the Texas and Pacific Railroad, Fort Worth, Texas, was burned December 14. Loss, $1000.

The Cotton Gin Plant of J. B. Washington, near Earle, Ark., was badly wrecked by the explosion of a boiler on December 7.

On December 12, several persons were scalded in the engine-room of the American Steel and Wire Co's. plant, Cleveland, Ohio, by a fly-wheel bursting and puncturing a steam pipe.

Albert B. Foxall, an employee of the Mark Mfg. Co., Muskingum County, Ohio, was scalded December 5, by the explosion of the company's boilers.

On the afternoon of December 5, a large gas engine and boiler in the Webster School, Wheeling, W. Va., exploded, causing damages to the extent of $500.

On December 4, a boiler in the German Home for the Aged, at Rochester, N. Y., exploded, killing one of the inmates of the home and causing considerable damage.

The power house of the Virginia-Portland Cement Company, at Fordwick, Va., was badly wrecked December 14, by the fall of a large steel girder, supporting the roof.

A boiler at the mill of James E. McWilliam & Son, near Hubbardstown, Mass., exploded on the night of December 9, fatally injuring a watchman and causing property damage to the extent of $12,000.

By the explosion of a boiler in the saw mill of J. W. Hartman, Woodville, Ala., on December 7th, William Thompson, the engineer, was seriously injured. The boiler was carried over 100 feet away from its foundation.

A large flywheel on the 500 H. P. engine at the Flint Wagon Works, Flint, Mich., burst into several pieces when the engine was started up after the noon hour, on December 3. One section went through the roof and another crashed into the cellar. George I. Wright, assistant engineer, was standing near the wheel when it exploded and narrowly escaped injury. Loss, $500.

By the explosion of one of the five boilers in the boiler room of the Greenwood Colliery, No. 2, of the Delaware and Hudson Company, Scranton, Pa., on the morning of December 4, John Cowley, an assistant fireman, was killed, his head being blown completely off, and several other persons were badly burned. The boiler carried away the side of the building and landed seventy-five yards away onto the main line of the Delaware and Hudson Railroad.

NEW BOOKS

The Blacksmith's Guide, by J. F. Sallows. Size 4½x7¼. 150 pages and 160 illustrations. Published by The Technical Press, Brattleboro, Vt. Price, $1.50.

The contents of this book are the result of the author's twenty-seven years' experience and includes machine forging, tool forging, hardening and tempering, high speed steel, casehardening and coloring and brazing. The book is well written and clearly illustrated, and should be a valuable addition to an engineer's library, especially if the hardening, tempering or forging of tools comes under his supervision.

Webster's International Dictionary. 2380 pages, 5000 illustrations. Published by G. & C. Merriam Co., Springfield, Mass. Price, $10.75.

This recently enlarged edition of Webster's International Dictionary is printed from new plates throughout, and besides its regular contents contains 25,000 new words and phrases, a revised gazetteer of the world and a revised biographical dictionary. As the world progresses, there are changes in the language as well as along other lines, so that the latest dictionary is necessary to the man who wishes to be up-to-date in spelling and the proper definition of words.

The Steam Engine, by W. S. Leland and W. B. Snow. Size 6½x9½. 150 pages and 63 illustrations. Published by the American School of Correspondence, Chicago, Ill. Price, $1.00.

It is doubtful whether in only 150 pages it would be possible to embody more subjects pertaining to steam engine practice than is embodied in this book. The book is divided into four sections, namely, details of construction and types of engines, engine room accessories and engine operation, thermo-dyamics of the steam engine, and the steam turbine. Each subject is treated briefly and concisely and is illustrated intelligently. The book should be of value to anyone who desires a general knowledge of the workings and application of the steam engine.

Valve Gears and Indicators, by Walter S. Leland and Carl S. Dow. Size 6½x9½. 150 pages and 105 illustrations. Published by the American School of Correspondence, Chicago, Ill. Price, $1.00.

The subject of valve gears as taken up in this book adds nothing to this subject which has not already been written a number of times. It does, however, put the subject in a concise form for the purpose of self-instruction and home study. The explanation of the Zeuner valve diagram takes up too much space to the exclusion of much other valuable information which could easily have found its way into these pages.

The second half of the book devoted to steam engine indicators is also more or less disappointing, as it mentions nothing about some of the latest types of indicators or indicator motions. To a person, however, who has had no indicator practice and who wishes to study for himself the fundamental principles involved in taking and calculating an indicator card, this chapter should prove useful.

Perhaps the idea of condensing these two very important subjects under one cover has led to cutting down the subject to a minimum, but some slight elaboration of some of the subjects treated might add to the value of the book.

Mechanical Drawing, by Ervin Kenison. Size 6½x9½. 160 pages and 140 illustrations. Published by American School of Correspondence, Chicago. Price, $1.00.

This book, which is intended for self-instruction and home study, describes the instruments and materials used in mechanical drawing; geometrical definitions, geometrical problems and projections. To a person who knows nothing whatever of mechanical drawing this book may be useful, but to the student and engineer who wishes to increase his knowledge of drawing machine parts, this book will not be of much aid, as nearly one-half of the book is devoted to geometrical problems and definitions which may or may not be important to the practical draftsman. There is not one explanation or illustration showing how a machine part is drawn, and it would be rather difficult for the student to apply the principles of projection as described in this book to his work. If more practical information on real mechanical drawing were given, the book would be very much more valuable for the purpose for which it is intended.